CONSEIL PERMANENT INTERNATIONAL POUR
L'EXPLORATION DE LA MER
34B STRANDVEJ, HELLERUP–DANEMARK

RAPPORTS

ET

PROCÈS-VERBAUX DES RÉUNIONS

VOLUME XCVII

THE INTERPRETATION OF THE ZONES ON SCALES OF SALMON, SEA TROUT AND BROWN TROUT.

BY

T. H. JÄRVI, HELSINGFORS. AND W. J. M. MENZIES, EDINGBURGH.

EN COMMISSION CHEZ
ANDR. FRED. HØST & FILS
COPENHAGUE

Avril 1936.

TABLE OF CONTENTS

Page

Introduction 5

List of common Expressions for Salmon *(Salmo salar)* 12

Salmonidae. List of Genera and Species in Europe 14

Scale Material

Salmon

Parr and Smolt 16

Smolt, First Sea-Stage 19

Maiden Fish 20

Kelts and Previously Spawned Fish 30

Previously Spawned Fish 33

Abnormal Scales 43

Sea Trout 52

Brown Trout 62

THE INTERPRETATION OF THE ZONES ON SCALES OF SALMON, SEA TROUT AND BROWN TROUT.

determination and length calculations are sible from the scales of salmon and sea but as is the case with most other fishes. n the scales are normally well-marked, ttle dubiety about the interpretation of the and accurate results are comparatively tained. The scales of sea trout exhibit eater variations both in the intensity of kings and in the time of year at which the ones on the scales are formed. There are differences in the extent of the absorption scale material during the ripening and seasons. Brown trout scales offer even ous difficulties than do scales of sea trout. s paper it is proposed to give a very short f scale reading as applied to these fishes ease of reference the paper will be divided ts dealing with each species separately.

reproduction of scales from the North Sea n published side by side with those from c in order that readers may compare simi- s well as differences more easily. When g the interpretations of scales from the s and when noticing differences in the it should be borne in mind: the characters o waters are vastly different. In the North summer is long, the winter short, while in hern Finland the summer is very short winter long with much snow and ice; the f immigration is a short one only — say weeks at the utmost — during June and o distinction can be made. therefore, be- ring and summer. The older salmon ar- t, then the .2+ group and finally the up; the latter groups, consequently, show zones during the summer period, while owth is not shown or is very small in on the scales of older salmon. Spawning ice in October or immediately before the up of the river; few individuals descend utumn, most of them go down when the ks, i. e. in May—June. The spawning may thus be said to last 10 to 11 months est part of one year, a fact appearing in pretation of scales as .... G 1 G 1 .... formula "G" stands for a spawning year for a full intermediate year at sea.

rout usually ascend either before or after on, i. e., by the end of May or end of – beginning September. In both cases the a trout are beginning to ripen only. The spawning period of sea trout in Finnish waters is at yet not sufficiently investigated, the early immigrants are supposed to spawn during autumn while late individuals may not ripen during that winter. Sea trout are therefore interpreted like salmon as G 1 G 1 and not G + G + etc.

Salmon *(salmo salar).*

The salmon has a well-defined and orderly life cycle. After a preliminary existence of from one to five (exceptionally six but normally two or three) years in fresh water it migrates to the sea where it spends a further period of one to five years before again returning to fresh water. After its journey up the river from the sea it spawns and comparatively few fish, usually less than 5 %, survive to repeat the journey and to spawn on a second occasion.

The ova are deposited in gravel in the main river and small streams during the later autumn and early winter months. The period of incubation is dependent on the water temperature but the small fish do not generally hatch out until spring conditions are beginning to return. Paget has shown that the first of the scales are formed close to the lateral line in the middle section of the body probably some three or four weeks after the little fish has emerged from the egg, and that thereafter the remainder of the body covering is fairly quickly acquired.

The salmon, therefore, begins its life at the commencement of the growth period in a fresh year and consequently, since the scales start to register the progress of the growth of the fish immediately after their formation, the age which will be recorded later by them represents from the beginning practically complete growth years.

This is not the place to enter in to a discussion of the composition of the scale itself or to argue the necessity or otherwise of an application of a constant to the length calculations. It is now only necessary to deal with the superficial appearance of the scale as seen under the microscope.

The scale first appears as an approximately circular platelet in the skin and once the total number of scales has grown the increasing area of the skin surface is covered by an increase in the size of the individual scales. At first the increase is obtained by the growth of the scale material apparently in the form of lines, but in sections it is shown as

really in the form of ridges, round the original circular platelet (Fig. 1).

Later as the scale develops it normally ceases to be circular, becomes oblong and the lines or ridges cease to grow right round the periphery. The scale is now assuming its final form in which about two-thirds are deeply embedded in the skin and one-third is on the surface of the skin surrounded by only a thin layer of epidermis. The ridges are formed on the portion in the scale pocket only and the outer or so-called exposed portion is ridgeless and useless for the purposes of investigation (Figs. 2, 7, and 8).

Fig. 1. (M 1). +. Salmon fry, 4 cm.; caught end of October, 1926, Carrol Ponds, Scotland.

Fig. 2. (M 2). 1. 1-year parr, 6 cm.; caught March, 1927, Brora Hatchery, Scotland.

During the first summer of life the little fish feeds and grows freely and the scale ridges are well-spaced and well-formed. With the advent of cold weather feeding rather rapidly slows down and finally stops, little or no growth is made and little or no addition occurs on the scale. The winter is recorded rather by a check in the growth ridges than by an aggregation of fine ridges such as grow in the later winters of life. When spring returns rapid growth recommences and the addition of the new scale material emphasises the check which occurred during the winter months. (Figs. 3 to 6).

During the second winter, feeding and growth, although much more restricted than in the summer, are to some extent continued with the result that while the summer has been recorded on the scale by a band of widely spaced ridges the winter is shown not merely by a check but by a small zone of ridges finer and more closely spaced together than the summer ridges. It is at this period that we first get the two zones, one of widely spaced ridges representing rapid growth in the summer and one of narrowly spaced finer ridges representing the growth in winter which, together, can be accurately read as representing one complete year in the life of the fish (Figs. 7 to 10).

The move of the small salmon from fresh to salt water occurs at various ages accordingly to the type and geographical position of the river in which the fish live. Near the southern limit of the range of the salmon they may migrate to the sea sh after the end of the first year of life. The majority in Europe do so after two years i river but in the more northerly Scottish rivers in the Norwegian and Baltic rivers a propo higher as progress northwards is made, ma move to the sea until after the 3rd, 4th o year of life.

The fry which were hatched in the sm tributary streams may have moved out in t larger tributaries or the main river during the summer of their life and the parr, whatever age, which developed in to smolts begin to go the river to the sea, probably in March. They r tidal waters in small numbers in April and majority do so in May. By the middle of all have reached salt water. Although the d ward migrating smolts feed in the course of progress, the majority in Scotland, and probabl the other more northerly countries also, reach waters without showing any addition of r growth to the last winter which is recorded on t scales (Fig. 7). In more southerly rivers an some cases in Scotland, especially with the l migrating smolts, a small addition of rapid gr is made to the scales before the sea is rea (Fig. 8).

This final rapid growth, however, cannot confused with the growth which is made mediately afterwards. The sea growth is immeas ably superior to that in the river and is reco on the scales by correspondingly large and l ridges (Figs. 11 and 12). At this period fish wh enter the North Sea and the Atlantic from Europ waters are normally lost to observation, altho some have been taken by Professor D a h l mackerel nets off the Norwegian coast and a isolated specimens have also been obtained in S land. In the Baltic, however, it is more ea possible to follow their progress owing to fishery for the young salmon which exists at southern end of that sea. This fishery and mark experiments carried out in Scotland have clea shown that the scale record made in the sea similar to, but much more intensified than, record made in fresh water. The summer denoted by a rapid growth zone on the scales a the winter by a slow growth zone of finer a more closely spaced ridges.

The small salmon caught in the sea are mature and the first of them which return to river are maturing fish in their second sea y and known as grilse or St. Jacob's salmon. Th return to the river during the summer mont chiefly in June, July and August (exceptiona May, September and October; grilse are also casionally recorded on the Scottish coast as early the end of March). The first of these returni grilse have made little additional growth duri their final summer in the sea (Figs. 13 to 15). the height of the run more growth is shown and

se may show a complete summer's feeding
.
e salmon which do not return as grilse
ne back in the following year of life. The
hese may appear in the rivers as early as
r November with the intention of remain-
ically a complete year before they spawn
their scales in a condition very similar
hown in Fig. 16 without, of course, any
The greater part of the run of small
sh, however, occurs between February and
n the winter slow growth band on the
completed, but before any rapid growth
(Fig. 17).
neral terms it may be said that the slow
and is formed in the winter months but it
be shown in fish caught in the sea as late as
and on the other hand it may occur in
aught in the sea as early as November.
er members of the salmon population
or still longer periods in the sea and may
n until during the third summer after the
gration (Figs. 18 and 19), for another year
and 22), or even for another two years
3, 24 and 25).
nly complication which occurs in reading
s of maiden (i. e. unspawned) salmon is
check during the progress of the rapid
f the fish and which is recorded by the
nation of two or three ridges on the scale.
ck may occur in any year of sea life but is
mmon in the first and second summers. It
ded on Fig. 26 where it is shown as
g at the edge of the scale. In Fig. 28 it
during the first summer in the sea. In-
ons have revealed that this check is
y formed about the end of June or early in
l that it is accompanied by a break in the
of the growth of the fish and usually by
drop in their condition (K).
check is invariably slight and, apart
er from its obvious position on the scale,
very seldom exists of it being confused with
winter band once the technique of scale
has been acquired.
ediately sea feeding ceases and the fish are
way to fresh water they begin to call on
serves of nourishment and in this process
es as well as the internal fat yield toll. The
on commences at the outer corner of the
cket in which the greater part of the scale
dded and progresses both round the peri-
f the scale and inwards towards the centre.
it is slight and in the early months its
may not be rapid, but later in the year
ion progresses comparatively quickly. The
f a marked fish are given on Fig. 29 with
rption and on Fig. 30 the scale of the same
ken eight months later are shown. Com-
of the two illustrations clearly indicates
gress of the absorption in the interval.

In the case of females which have been in fresh water for a long time (e. g. about a year) absorption may extend right round the scale (Fig. 31) and may have eaten to some extent in to it but in the case of males it is very much more severe and in extreme cases may have destroyed the greater part of the scale material (Fig. 32). So much more severe is absorption in the case of males and so characteristically does it attack the scale that it is possible to determine the sex of the fish from examination of the scale alone. The male scale after absorption has occurred is often of a typical triangular section (Fig. 37).

It can be said that practically all salmon which spawn record this fact by the absorption of their scale material but in some few cases of extremely late running fish which may not enter the river until December or January and may spawn in February or even March the absorption may be so slight as to be very difficult to detect even in the case of a male. The illustration (Fig. 33) shows the scale of a partially spawned male fish taken in the River Tweed (Scotland) in February 1928.

Such of the kelts as survive after spawning gradually drop down the river and return to the sea there to recommence feeding first of all to make up for the material which they have lost during their freshwater residence and later to add further growth to their original size. In so doing new material is added to what remains of the original scale and at the junction of the new growth with the absorbed and ragged edge a scar is formed which indubitably records the past history of the fish. This scar is easily identified from a winter band by reason of the fact that the new ridges of growth are set at an angle to and not parallel with the old ridges (Figs. 34, 39 and 40) and the later ridges while added after the junction of the old and new material has been completed are approximately parallel with those which have just been laid down. The most rapid growth is shown along the sides of the scale and represents the effort made to replace the loss of rotundity in the river while the less rapid growth at the apex of the scale represents in great part an addition to the original length of the fish.

If a fish remains for more than a summer in the sea before returning to spawn again then the fact is recorded in a normal fashion by the growth of a zone of narrowly spaced ridges at the edge of the scale (shown slightly in Fig. 37) and if it continues in to a second summer then that fact is again also recorded (Fig. 42). Some few are sufficiently fortunate to survive to spawn for a second (Fig. 41, 43) or third (Fig. 44, 45, 46, 47), or even a fourth time (Figs. 48 to 50) and to return to the river again later, while an altogether exceptional fish may spawn even five times (Fig. 51), although no record beyond the fourth spawning period is obtained since this particular fish was taken as a kelt before it had returned to the sea.

Spawning marks are occasionally difficult to detect as in the case of fish previously mentioned (Fig. 33) which exhibit very little erosion at the kelt stage. Careful examination of the ends of the ridges near the exposed portion, however, will practically always yield the true record of the real facts.

One source of error remains and that may be caused by a pseudo spawning mark due to an injury to the skin of the fish and consequent misplacement of the scales. In such circumstances scales may be moved or slightly rotated in the skin pockets and the junction of the growth before and after the injury leaves a scar on the surface. Such scar, however, if carefully examined does not closely resemble that of a true spawning mark since the edge of the scale at the scar is intact and not serrated as is the case after absorption. This type of abnormality is not common but is shown in Fig. 52 which was taken from the site of an injury.

It should be mentioned that one of the chief difficulties in determining the age and growth of part of the Baltic salmon is due to the checks which are formed during the first year at sea. These difficulties are increased, further, as in the case of the grilse material from 1933 or the small salmon material from 1934, if the growth of the year in question was poorer than normally. Besides, it may occur that the first check lies so near to the last winter band of the parr stage that it is difficult to decide whether the area within the check has developed during river or during sea life. In assuming the first case one runs the risk of interpreting the parr stage as one year too long and of interpreting the growth made during the first year at sea as too little. These should be the chief causes of error occurring in dealing with material from the Baltic; the first winter zone of the parr stage, however, may sometimes also be omitted.

The spawning mark, on the other hand, of the Baltic salmon can rarely be overlooked. In order to spawn they migrate over long distances, firstly through areas of the sea which are relatively poor in food fishes, and then up rivers which are rough and of considerable length. Consequently, the time taken in migration is prolonged. The chief period for the ascent of both small and large salmon is the later part of June, and of grilse the later part of July and the beginning of August. Most of the ascending salmon stay in the rivers during the ensuing winter and until late spring when the ice breaks up in the beginning of May. Under these conditions the spawning salmon grow extremely thin and the erosion of the scales consequently becomes considerable and very obvious. The scales of salmon that have never spawned are therefore in striking contrast to those of salmon that are ascending the river for the second or third time.

Further details will not be dealt with here, but one very exceptional case (Fig. 48—50) shows erosion in four successive years — the 2nd, 4th and 5th — and growth in each year since smolt stage. The erosion does not extend along whole edge of the scale. This case was interpr as indicating an individual belonging to a typ salmon which is very rare in the waters of Baltic; a type which goes up to the lower p of the rivers and spawns there for several y in succession — in this specimen 4 times. very limited erosion was consequently read as indication of a short life in the river and it concluded that the individual in question — un the Baltic salmon generally — had not spe complete year in ascending and descending river and another year in recovery and growth the Baltic. According to this interpretation the reads as 4 years less than it would be in the dinary type of Baltic salmon.

A very small acquaintance with scales will monstrate the presence of certain abnormal sc in which a greater or lesser extent of the cen portion has no ridges. This abnormality is due the loss of the first scales and to a rapid regen tion of the scale material to replace the loss u the necessary scale size is completed and nor growth can be resumed. The rapidly regenera scale has no normal surface markings, e. g., Figs 13, 37.

Another type of abnormality sometimes seen a hole in the scale. No exact reason for this yet been ascertained but it is presumably due the efforts of some small boring animal. This h may be filled again with scale material and though the ridge forming cells are apparen damaged or misplaced they do not entirely fail function as in the case of scales which are entir regenerated. The ridges, however, may be pla eccentrically to the original ridges (Fig. 53).

Sea trout *(salmo trutta)*.

The remarks on the conformation and read of salmon scales apply in general to those of trout. Indeed the similarity is so close that ma details applicable to the one are equally applica to the other.

In general, however, sea trout scales are m difficult to read and measure than are those salmon. The scales of the smaller fish vary co siderably more in their appearance than do th of salmon and in many districts the winters and spawning marks are by no means so clea delimited as are the similar markings on salm scales. Sea trout scales may be further complicat by the growth of many false checks and by t formation of the slow growth band, apart from t accidental false checks, at a period other than the colder months of the year.

The general appearance of sea trout scales similar to that of a salmon and the transition fr fresh water to sea life is equally clear. Unli

e younger sea trout first reappear from existence during the first summer of their ation life (Fig. 64). Under normal con- f marine growth the sea trout form a nd at the edge of the scale as winter s (Fig. 65) just as do salmon and this y be created at any time between Sep- d April of the following year.

numbers of adolescent sea trout however, winter in fresh water without spawning descend to the sea and form a band of aced ridges at the edge of the scale before enter in to the period of intensive feed- apid growth. Fig. 66 a and 66 b shows the a fish marked in November and re- in September. Under normal conditions , 72) the passing of the winter, if not r itself, is recorded on the scales and the he fish is clearly shown just as a fish d spent a further year or two years in r also clearly reveals that event (Figs. 68, 0).

maturity is approaching sea trout scales show absorption of the edge and after nd growth has been renewed a spawning ut which no dubiety can exist is found. e state of normal record occurs in the ish which spawn once (Figs. 71, 73, 74, ose which spawn on many occasions (Figs. 7).

ted above the normal marking on sea trout though distinct, is not so clear as in the almon. At times the clarity may diminish culty may well be experienced in deciding re a winter should be shown on the scales er any particular band of narrow ridges a check or is a true winter band.

earliest difficulty is likely to occur at the en the young fish in the smolt stage pass h to salt water. Sea trout more frequently non may spend the last year of their life waters of the upper estuary and while y apparently continue to feed throughout winter of ante-migration life so that no wth band is recorded on their scales. From nce they gradually pass to the fully marine ration life without leaving on their scales ace of the event. In such cases close ion of the scale must be made before the can be detected. On the other hand a t similar scale formation, but with a type of growth after the preliminary parr d a more definite check may indicate a ype of life with a check during the first in the sea.

ntrast to those difficulties and abnormal- scales of sea trout from some districts are nally clearly and definitely marked (Fig. even among these the problem occurs of a identally moved and damaged which shows false appearance of a spawning mark.

Probably because many of the fish leave the sea feeding grounds late in the year and only a short time before the spawning season the amount of absorption which takes place during the spawning period may be comparatively slight. A marked feature is that such absorption may not be regularly shown and may appear only on certain scales of each individual fish. It is necessary, therefore, to examine a series from each specimen in order to be certain on this particular point.

In consequence of this feature the spawning mark may be slight and difficult to detect but since absorption starts in the same fashion as in the case of salmon, that is from the corner of the skin pocket where the ridges join the exposed portion of the scale and the subsequent new growth is put on at an angle to the old ridges careful examination will reveal its presence and the true history of the fish (Fig. 78).

The growth and appearance of sea trout scales varies so enormously from district to district and the abnormalities may similarly vary to the same extent that in the case of this species it is necessary that a scale reader should approach a new district with caution and should check his readings by means of marked fish or through a very careful study of an adequate number of samples taken over an extended period before he makes any definite pronouncement of his findings.

Brown trout *(salmo trutta var. fario).*

The scales of brown trout present perhaps apparently fewer difficulties of interpretation than do those of sea trout. They are not subject to so many checks and variations in the time of formation of checks but they cannot always be taken as a reliable index of the age or the exact life history of the fish. It is possible that in certain districts (e. g. moorland peat waters) trout may practically cease to grow after a certain size and that the age may consequently cease to be recorded on the scales. It is quite certain that in many cases no scale absorption takes place at the spawning period and that consequently no spawning mark is formed thereafter.

Bearing in mind these very definite limitations the reading of brown trout scales may be approached with confidence and little hesitation need be given in the interpretation in the earlier stages (Fig. 79). The growth resembles that of young salmon and sea trout although in the same water brown trout usually grow better than either of the other species at this period of their lives.

In the larger and older fish the scale growth obviously keeps pace with the rather more rapid increase in the bulk of the fish but the general appearance is much more closely akin to that of the earlier years (Fig. 80) than in the case of sea-going fish.

Only occasionally is absorption seen at the edge

of the scale (Fig. 81) and consequently the spawning mark (Fig. 82) is by no means as common as would be the case did all the fish which have spawned bear this record.

Collecting and preparing scales.

If scales are collected only for purpose of age determination the position on the body from which they are taken is of minor interest, thus all Finnish scales reproduced in this publication are taken between the adipose fin and the lateral line; — for purpose of growth calculations scales secured immediately above the lateral line and below the dorsal fin are considered best.

The common practice in Finland and in Great Britain where, as in other countries, it is not always possible for the investigator himself to collect scales, may be explained by the following instructions. Scales should be taken by means of tweezers or the blade of a knife and without further handling placed in small paper bags (size 8 by 4 cm.) in which the wet scale will cling to the paper and dry; weight, length, date etc. should be written on the bag itself. It is an advantage if the flap of this bag or envelope is not gummed.

A dissecting microscope should be used in selecting the best scales from the bag; viz. those that have the central part with all zones intact. The selected scales may be softened if desired by submersion in water for some minutes on the object-glass; if necessary scales may be cleaned by rubbing between the fingertips. No further preparation is necessary for ordinary scale reading.

A microscope projector (such as the Edi microscope) is of great assistance when l numbers of scales have to be read or when le calculations or photographs have to be m Scales need no preparation for preservation, will not suffer from being stored in paper b and are ready for future examination.

The attention of those interested in the in pretation of the markings on the scales of the monidae is particularly directed to the follow publications.

"Rap. et Proc.-Verb. Vol. XCI."

"Report on the Scales of some Teleostean F with Special Reference to the Method Growth" — Geoffrey W. Paget — "Minis of Agriculture and Fisheries Investigatio Series II — Sea Fisheries, Vol. IV, No. 1920."

"Difficulties of Age Determination and Len Calculations from the Scales of Sea Tro — G. H. Nall and W. J. M. Menzies "Fisheries, Scotland, Salmon Fish., 19 No. V."

"Scale Absorption in Salmon and Sea Tro — M. Ian Crichton, B. Sc., "Fisheri Scotland, Salmon Fish., 1935, No. IV."

"Sea Trout of the Montrose District, Part II Growth on the Scales of Recaptured Fis — G. H. Nall — "Fisheries, Scotland, S mon Fish., 1935, No. II."

LISTS
OF
COMMON EXPRESSIONS,
GENERA
AND
SPECIES

List of common Expressions for Salmon (*Salmo salar*).

		Denmark	Finland	France
Alevin	Newly hatched fish with yolk sac attached	Yngel	Kuoriutunut poikanen	Alevin vésiculé
Fry	Yolk sac absorbed and fish started to feed		Vastasyntynyt poikanen	Alevin libre
Parr	From first summer of life until smolt stage	—	Lohenpoikanen; Tonko (= Oulu-river) Karirautu (= Kemiriver)	Alevin d'un an
Smolt	Parr in silvery dress descending to sea ..	—	Muuttopoikanen Kiiltopoikanen	Tacon, Glizik, Rénet
Mielnica	Fish during first year of sea life	Smaalaks	Pikkulohi	—
Grilse	Fish in second summer of sea life	Smaa Sommerlaks	Kossi	Madeleineau, Castillon. Gerbillot
Small spring Salmon	Fish in second winter and early spring of sea life.	—	Pienilohi	Spring salmon = Saumon de printemps summer salmon = Saumon d'été Winter salmon = Saumon d'hiver
Small summer Salmon	Fish in third summer of sea life	Større Sommerlaks		
Large spring Salmon	Fish in third winter and early spring of sea life.	Stor Vinterlaks	Iso lohi ♂ = Kojamo, Ukkolohi	
Large summer salmon	Fish in fourth summer of sea life	—		
Very large spring salmon	Fish in fourth winter and early spring of sea life.	Meget stor Vinterlaks	Suurlohi ♂ = Suurkojamo, Suur-ukkolohi	
Very large summer salmon	Fish in fifth summer of sea life	--		

Kelt	Salmon which has spawned and has not recovered from spawning.	Nedfaldslaks	Kutulohi Laskulohi	Charognard
Mended Kelt	Salmon which has spawned and has recovered its silvery appearance but has not yet started to feed	Blank Nedfaldslaks	Toipunut lohi	—
Previously spawned Salmon	Fish which has descended as a kelt and and has fully recovered its condition in the sea.	—	Ennen kutenut lohi	—
Short absence	A previously spawned salmon which recovers its condition in the sea and returns to fresh water in the same year as it goes down as a kelt.	—	—	—
Long absence	A salmon which has spawned, goes down to the sea and returns in the spring of the year following that in which it went down as a kelt..	—	—	—
Very long absence	Salmon which has spawned, goes down to the sea and returns to the river in the summer of the year following that in which it went down as a kelt	—	—	—
Maiden Salmon	A fish of either sex which has not spawned	—	Täysi lohi	—
Mature Salmon	A fish of either sex which has spawned in a previous year (i. e. synonymous with previously spawned fish)..	—	—	Saumon mature

olland	Iceland	Latvia	Norway	Poland	Portugal	Russia	Spain	Sweden
Larve mbroed	Lirfa	Pūslīša mazulis	Larve	Wycior	Alevim	Lichinka	cria	Laxyngel
		Mazulis	Yngel	Narybek	—	Malyok	—	
ge zalm	Seiði,	Vienvasaras mazulis	Tit	Palczak	Caloiro	Pestryatka	Alevin y Escaramujo	Laxunge
ekkende Zalm		Lasēns	Blinke		Novatos	Serebristaya pestryatka	Esguin y Pinto	
—		Vienvasaras lasēns	—	Mielnica (*not* sea trout)	—	—	—	Smålax, Laxkalv
obszalm	Smálax	Divvasaru lasēns	Smaa-laks, Tert, (= West-coast); Svel (South-coast)	—		Tinda	Añal	
kleine merzalm		Mazs pavasaŗa lasis	Mellemlaks, Ternlaks	—	Spring salmon = Salmão de primavera Summer salmon = Salmão de verão	—	Salmón temprano o vernal pegueño	Blanklax
	—	Mazs vasaras lasis		—			Salmón estival o serondo pegueño	
Groote merzalm	Stórlax	Liels pavasaŗa lasis	Storlaks			Mezhen	Salmón temprano o vernal grande	
	—	Liels vasaras lasis		—			Salmón estival o serondo grande	Lax
Groote nterzalm	—	Ļoti liels pavasara lasis		—			Salmón temprano o vernal muy grande	
—	—	Ļoti liels vasaras lasis		—			—	
				Tarlak (= mature for spawning) Klemp (= ♂ ready for spawning)				
Hengst	Niðurgöngulax, Hoplax	Kriteja lasis	Winterstöing	Łosoś wytarty	Trancas	Valchak	Zancado	Vraklax, Grålax
—	—	Karns lasis			—	—	—	—
—	—	Atbarojies pēcnārsta lasis	Laks som har gydt för		—	—	—	—
—	—	Īsa prombutne	Kort Fravær	—	—	—	—	—
—	—	Ilga prombūtne	Langt Fravær	—	—	—	—	—
—	—	Ļoti ilga prombūtne	Meget langt Fravær	—	—	—	—	—
—	—	Śķīsts lasis	Jomfruelig Laks	—	—	—	—	—
—	—	Nobriedis lasis	Laks som har gydt för; Laks med Gytemærke	—	Salmão maduro	—	—	—

	Denmark	Finland	France	Germany	Great Britain	Holland	Iceland
Salmo salar	Laks	Lohi	Saumon atlantique	Lachs	Salmon	Zalm	Lax
S. trutta	Havørred, Ørred	Taimen	Truite de mer	Meerforelle, Lachsforelle, Silberlachs	Sea trout	Schotje	Urriði, Sjóurriði, Lækja-, ungur-, Vatnaurriði
S. trutta v. fario	Bækørred	Purolohi	Truite commune	Bachforelle	Brown trout	Forel	—
S. hucho	—	Huho	—	Huchen	Huchen	—	
S. lacustris	Søørred	Järvilohi	—	Seeforelle	—	—	—
S. irideus	Regnbueørred	Sateenkaarilohi	Truite arc en ciel	Regenbogenforelle	Rainbow trout	—	—
S. salvelinus	—	Nieriä	—	Saibling	Char	—	—
S. alpinus	Fjældørred	Rautu	Omble	—	—		Bleikja, Sjóbleikja, Vatnableikja, Murta
S. fontinalis	Kildeørred	Puronieriä	—	Bachsaibling	Brook trout	—	—
S. trutta macrostigma . .	—	—	Truite de montagne	—	—	—	—
Coregonus sp.	—			—	White fish	—	—
Coregonus albula	Heltling	Muikku	—	Kleine Maräne			
C. amnipetens	—	—		—	—		
C. generosus	—	—	—	Edelmaräne			—
C. lavaretus	Helt	Siika	Lavaret	Grosse Maräne, Wandermaräne, Ostsee-Schnäpel			—
C. lavaretus var. oxyrhynchus	Snæbel	Nokkasiika	—	Nordsee-Schnäpel	—	Houting	—
C. Wartmanni			—	Blaufelchen, Schwebrenke			—
C. macrophthalmus . . .			—	Gangfisch			—
C. fera	—		Féra	Sandfelchen, Weissfelchen, Bodenrenke	—	—	—
C. acronius			—	Kilch, Kropffelchen	—	—	—
C. Nilssoni	—	—	—	—	—	—	—
C. holsatus	-		—	Selenter-Maräne, Schaalsee-Maräne		—	—
C. hiemalis	—	-	Gravenche	—			
C. marœna	-		—	—		—	
Thymallus vulgaris . . .	Stalling	Harjus	Ombre	Äsche	Grayling	Vlagzalm	
Osmerus eperlanus . . .	Smelt	Kuore	Eperlan	Stint	Smelt	Spiering	
Argentina silus	Guldlaks	—	—	Goldlachs	—	—	
A. sphyraena	Strømsild	—	—	—	—	—	—
Mallotus villosus	Lodde	Villakuore	—	Lodde	—	—	Loðna

Europe.

	Latvia	Norway	Poland	Portugal	Russia	Spain	Sweden
...	Lasis	Laks	Łosoś	Salmão	Losos (Finnish Gulf) Syomga (White, Barents Sea)	Salmón	Lax Blanklax
...	Taimiņš	Sjö-örret Sjö-aure	Troć	Salmão truta Truta, Sapeira Truta marisca, Marinha Truta salmonada	Kumzha	Trucha de mar ó Reo	Laxöring, Grålax (= kelt!) Havsöring, insjööring Vätterslax (in the lake Vättern)
...	Strautu forele	Örret, Aure, Vass-aure	Pstrąg	Truta comum *(Levenensis)*	Forel, Kumzha Pestrushka	Trucha	Forell, Bäckforell Bäcköring
...	—	—	Głowacica	—	—	—	—
...	—	—	—	—		—	—
...	—	—	—	Truta francesa, arco iris	—	—	Regnbågsforell
...	—	Röie (Rör) Sjö-röie	Pstrąg	—	Palya	—	Storröding
...	—	Röie (Rör)	—	Truta assalmoada	Golets	—	Fjällröding
...	—	—	—	Salmão das Nascentes	—	—	Amerik. bäckröding
...	—	—	—	—	—	—	—
...	Sīga	Sik	—	—	Sig	—	—
...	—	Lakesild	Sielawa	—	Ryapushka	—	Siklöja
...	—	—	—	—	—	—	Gullspångssik
...	—	—	—		—	—	—
...	—	Sik	Sieja	—	Sig	—	Vanl. Sik
...	—	—	—		—	—	Näbbsik, Fetsik
...	—	—			—	—	Gråsik
...	—	—	—	—	—	—	—
...	—	-	—		—	—	—
...	—	-		—	—	—	—
...	—	—	—			—	Blåsik
...	—	—		—		—	—
...	—	—	—	—	—	—	—
...	—	—	—	—	—	—	Storsik, Lövsik
...	Alata	Harr	Lipień	Temolo	Kharius	—	Harr
...	Salaka	Krökle	Stynka	Eperlane	Koryushka	—	Nors, Slom
...	—	Guldlaks Vassild	—	—	—	—	Guldlax Strömsill
...	—	Strömsild	—	—	—	—	Silverfisk
...	—	Lodde	—	—	Moyva	—	Lodda

Fig. 3. (J 1) +: 5-month parr, 6.7 cm., 3.5 g., × 80; Sept., 1928, Kaihua ponds, Kemiriver, Finland.

Fig. 4. (J 2) +: 5-month parr with check; 7.6 cm., 4.4 g., × 80; Sept., 1928, Kaihua ponds, Kemiriver, Finland.

Fig. 5. (J 3) 1+: < 2-year parr, 10.1 cm., 10.7 g., × 80; Nov. 1929, Kaihua ponds, Kemiriver, Finland.

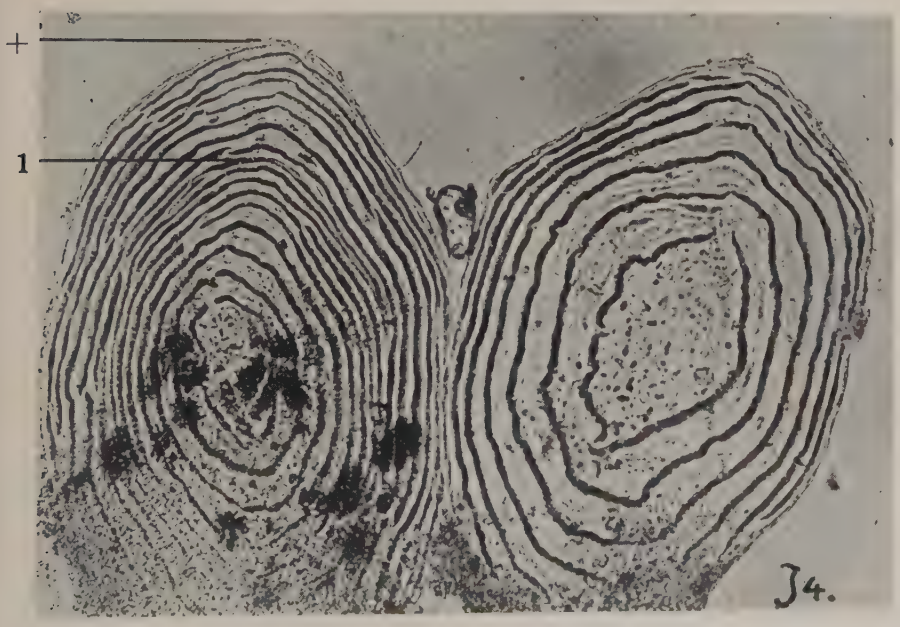


Fig. 6. (J 4) 1+: < 2-year parr, 8.4 cm., 5.8 g., × 80; Nov. 1929, Kaihua ponds, Kemiriver, Finland. Right hand scale regenerated late (after end of first year) with abnormal centre.

Fig. 7. (M 3) 2: 2-year smolt, 12 cm.; May, 1922, Dee, Scotland.

Fig. 8. (M 4) 2+: 2-year smolt with rapid growth, 14 cm.; May, Tees, England.

Fig. 9. (J 5) 2+: > 2-year parr. 11.4 cm., 15.7 g., × 80; Sept. 1929, Kaihua ponds, Kemiriver, Finland. (Erratum: "3." in block should be "3rd" as the bands 2.–3. do not indicate a full year.)

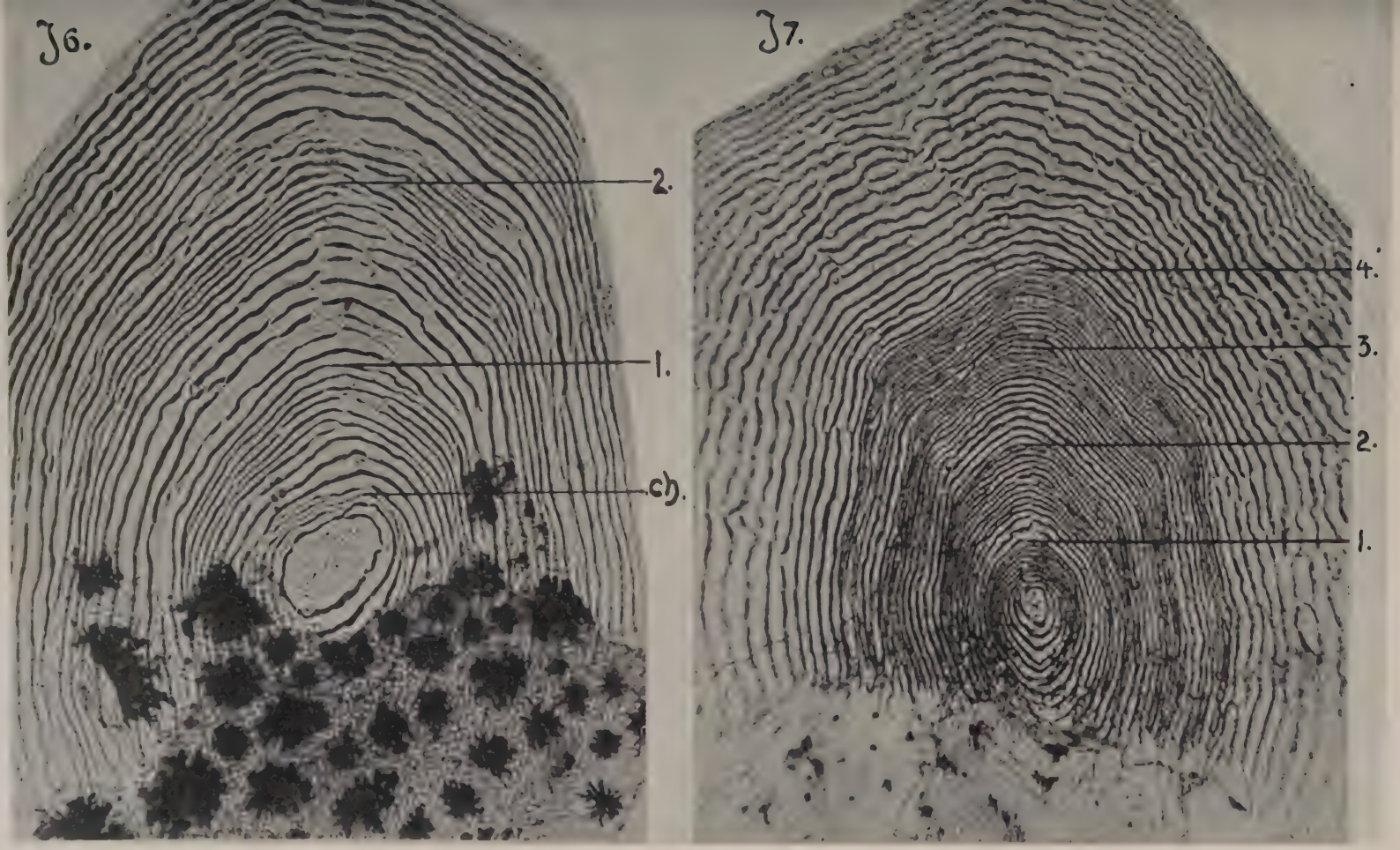


Fig. 10. (J 6) 2 — 2-year parr, 14.2 cm., 28.4 g., × 80: Sept. 1929. Kaihua ponds, Kemiriver. Finland.

Fig. 11. (J 7) 4 — 4-year ♂ mielmica. pre-grilse stage, 42 cm. 0.7 kg. × 34, Tornioriver, Finland.

Fig. 12. (M 5) 5.1: ♀ mielnica, pre-grilse stage, 37.5 cm.; 7/4/1933, Baltic.

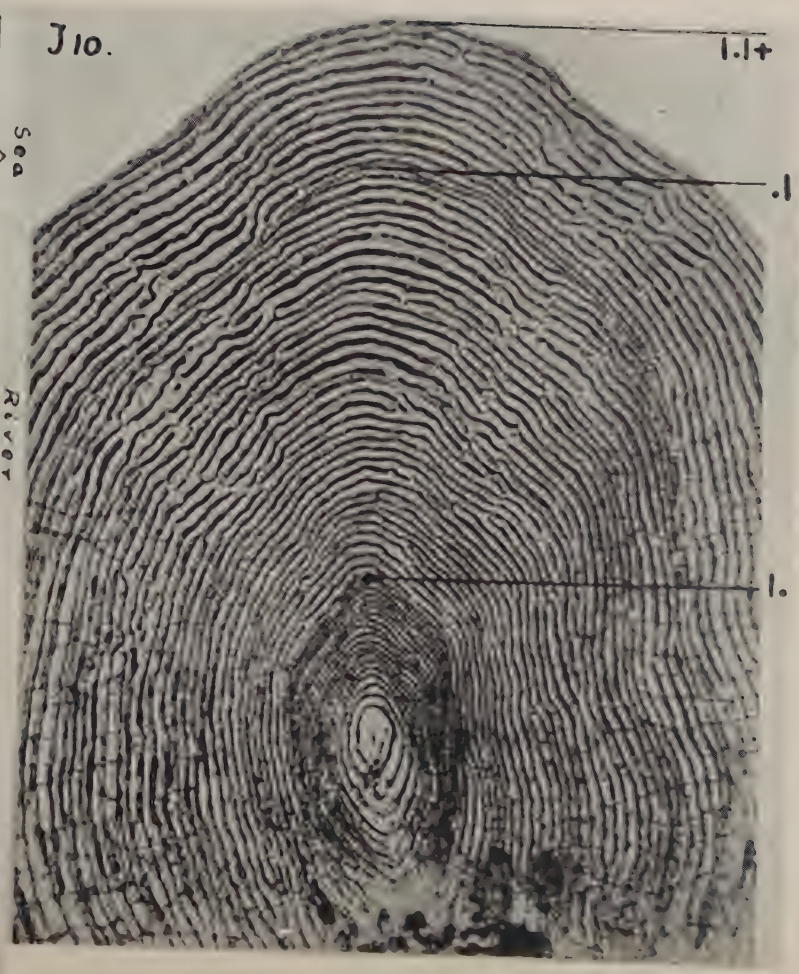


Fig. 13. (J 10) 1.1+: ♀ grilse, 45 cm., 0.9 kg., × 38; 26/8/1926, [illegible] Finland. Regenerated centre; may be 2.1+

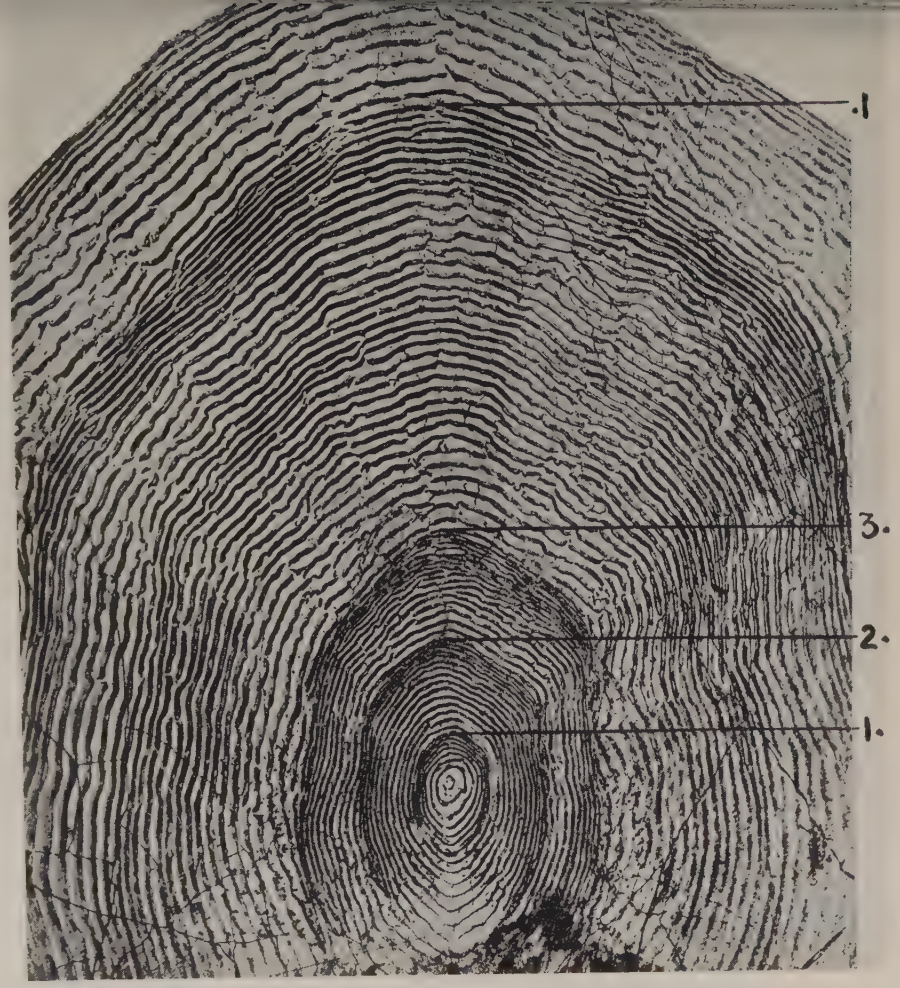


Fig. 14. (J 8) 3.1+: ♂ grilse, 52 cm., 2.5 kg., × 27; 21/7/1926, Kemiriver, Finland.

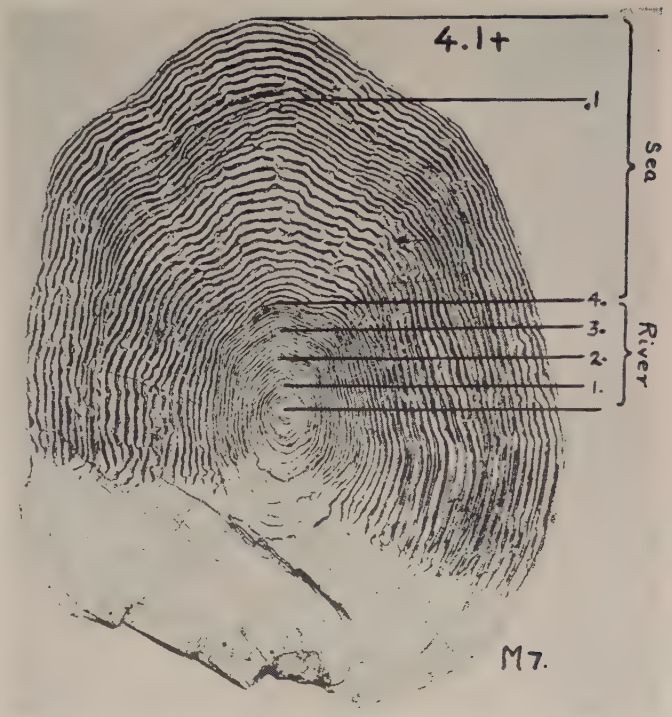


Fig. 15. (M 7) 4.1+: grilse with small amount of summer growth, 54 cm., 1.4 kg.; 31/5/1922, Spey, Scotland.

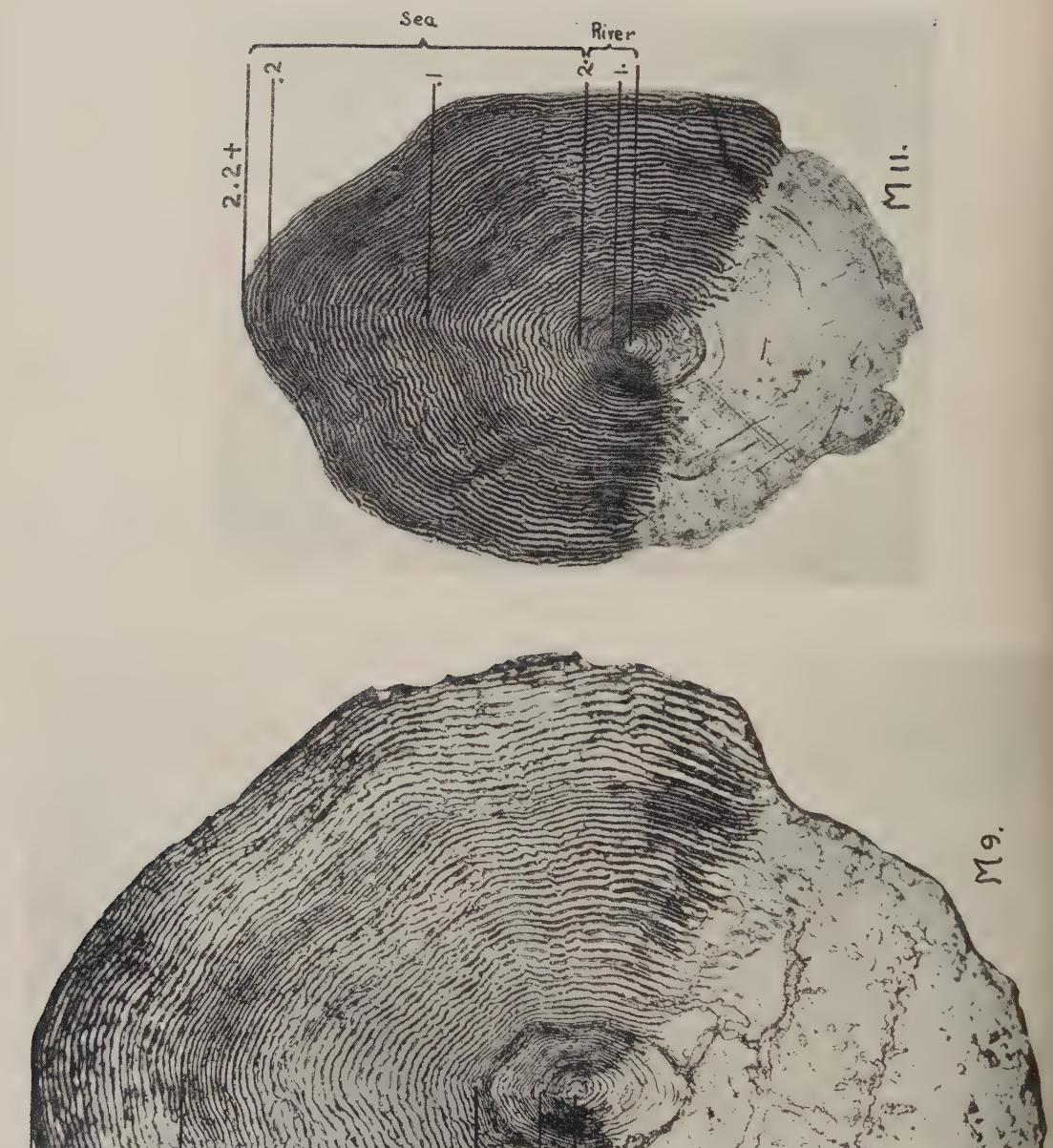


Fig. 16. (M 9) 2.1+ Fai. 9 kelt late grilse much t. 1/5/1925. Yd. Sandhaven

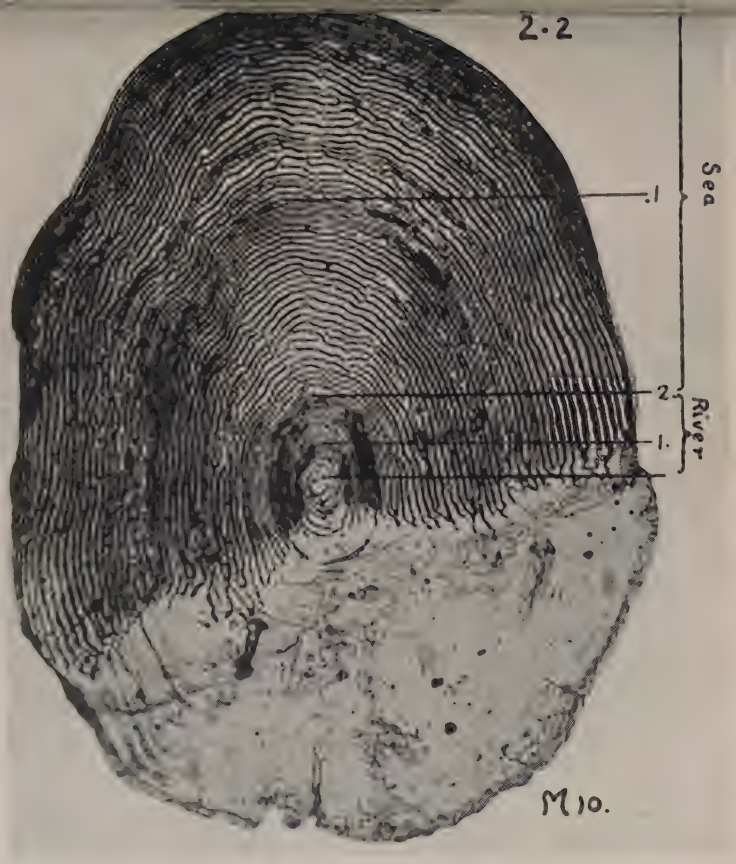


Fig. 17. (M 10) 2.2: small springer, 73 cm., 4.5 kg.; 26/4/1923, Spey, Scotland

Fig. 19. (J 11) 4.2+: ? maiden fish, 84 cm., 7.0 kg., × 26; 28/6/1931, Tornioriver, Finland

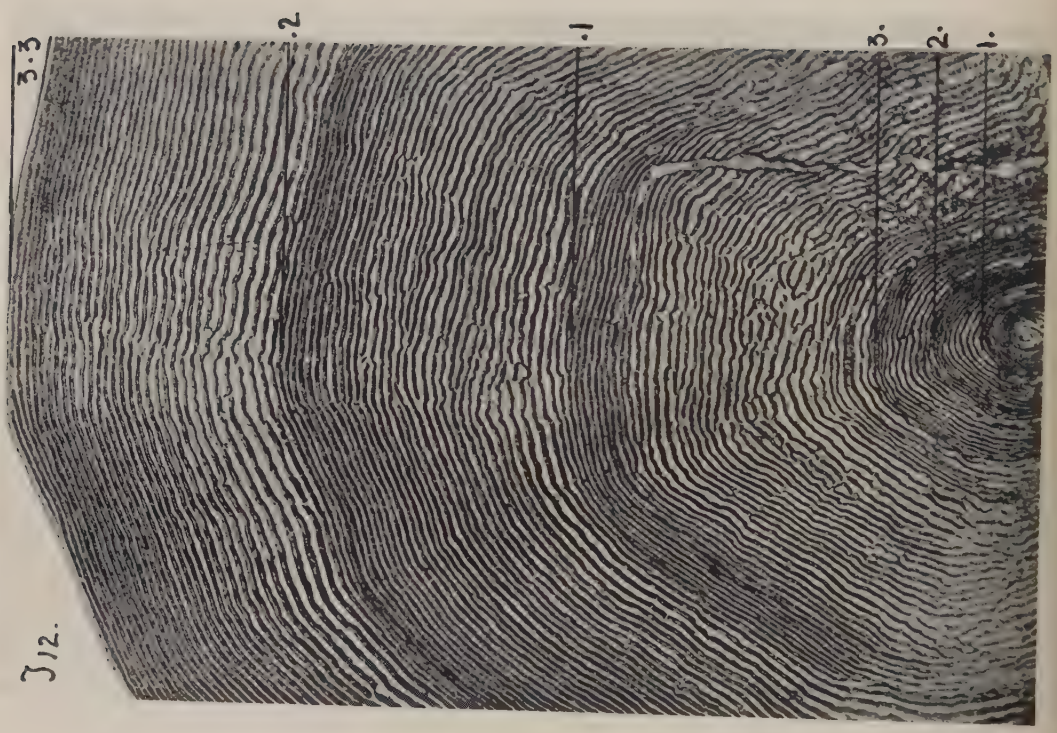


Fig. 21. (J 12) 3.3; ♀ maiden fish, 95 cm., 11.5 kg., × 23. 8/7/1927. Oulutiver, Finland.

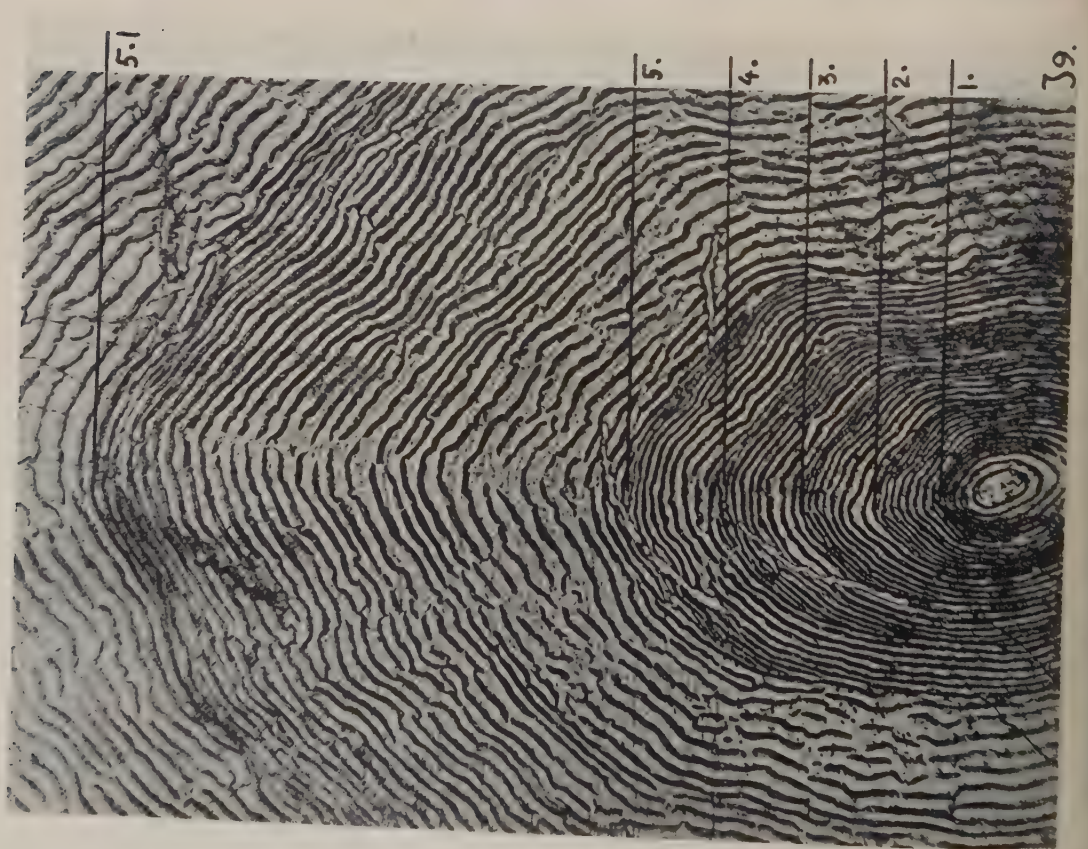


Fig. 20. (J 9) 5-year smolt; ♀ maiden fish, 86 cm., 6.5 kg., × 36; 22/6/1933, Kemiriver, Finland.

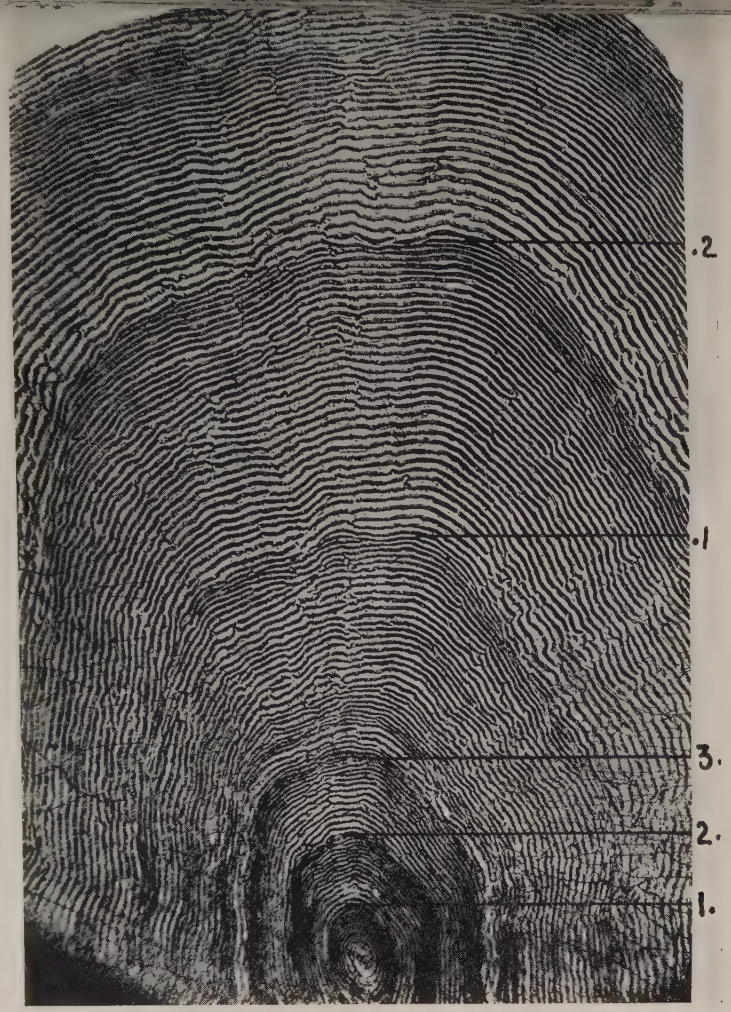


Fig. 22. (J 13) 3.3+: ♀ maiden fish, 97 cm., 10.5 kg., × 26; 26/6/1930, Kemiriver, Finland.

Fig. 23. (M 15) 2.4+, E_6: kelt, very large summer fish, 130 cm., 21 kg.; 16/2/1934, Solway Esk, Scotland.

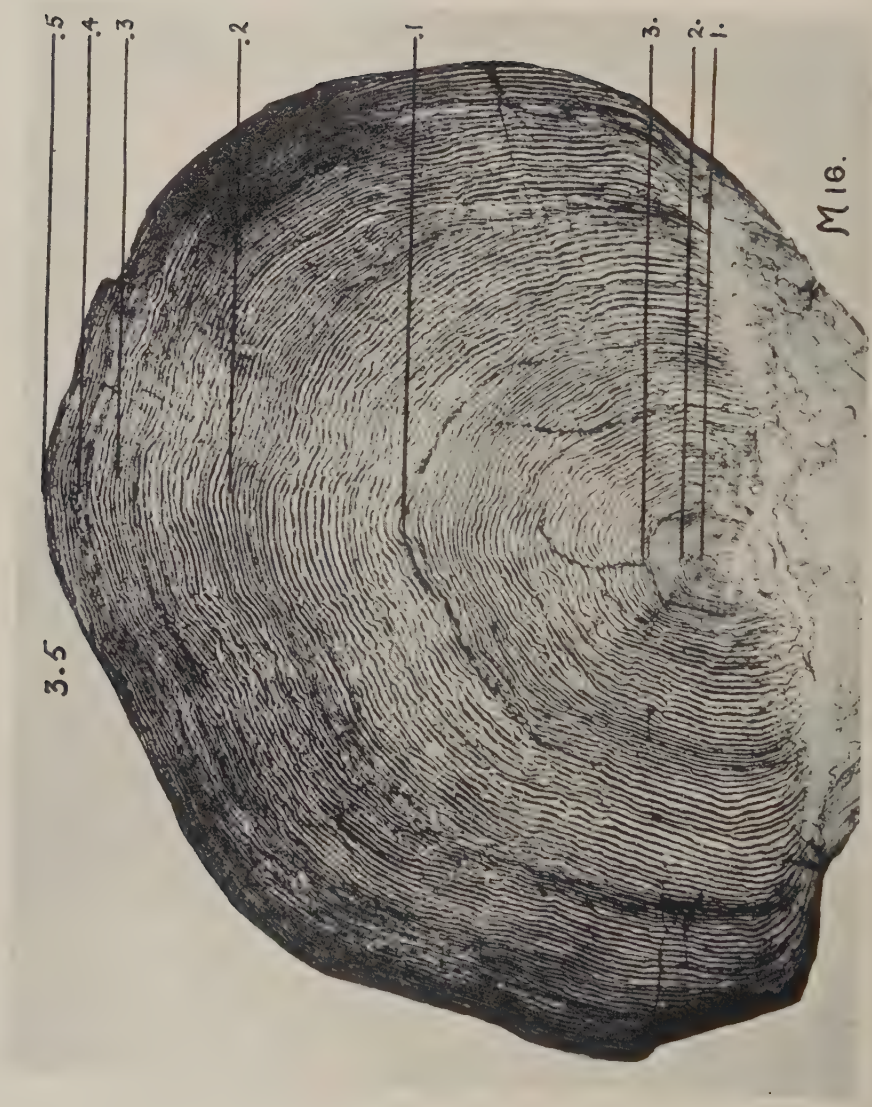


Fig. 24. (M 16) 3.5: maiden fish, 140 cm., 26.8 kg.; 31/5/1930, South Esk district, (Boddin), Scotland.

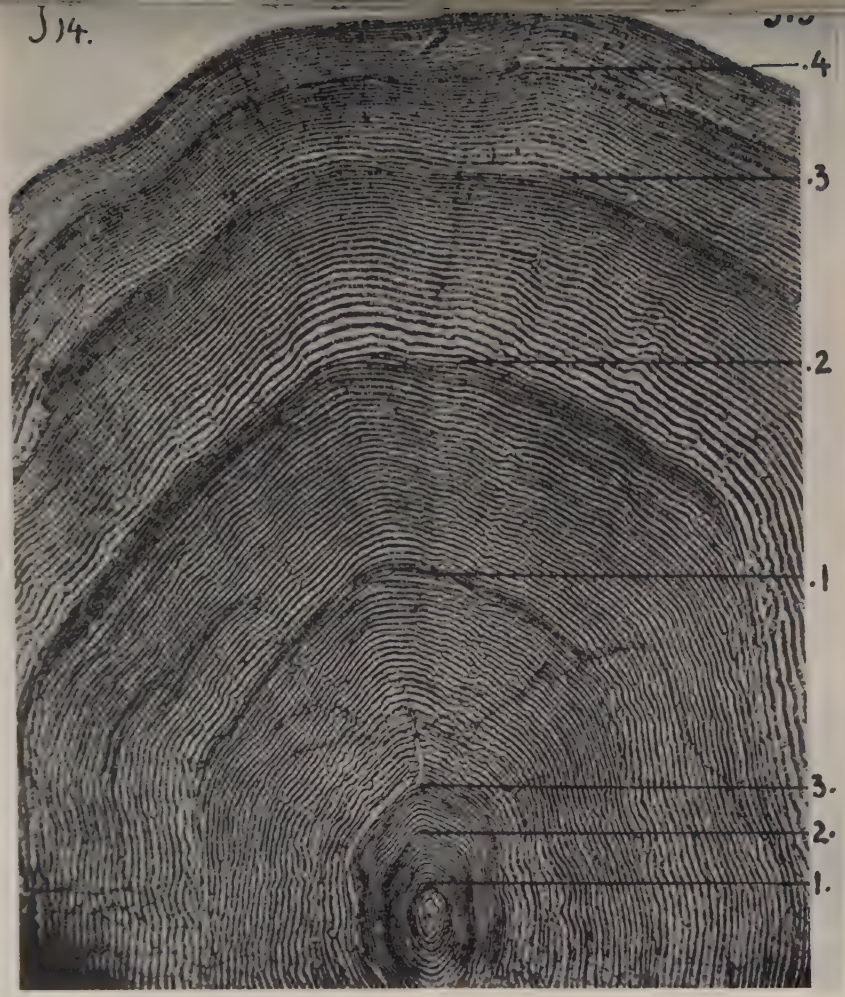


Fig. 25. (J 14) 3.5 ♂ maiden fish, 119 cm., 15.5 kg., × 18; 5/7/1930, Kemiriver, Finland.

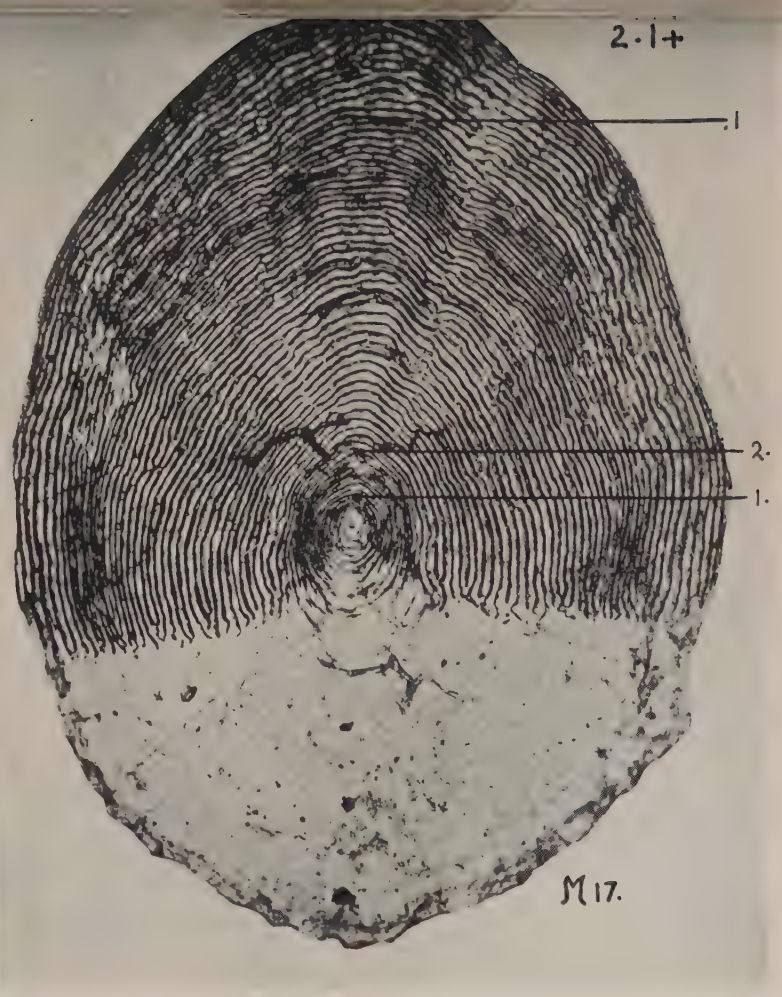


Fig. 26. (M 17) 2.1+, check at edge grilse, 63.5 cm., 2.8 kg.; 9/7/1934, Tay, Scotland.

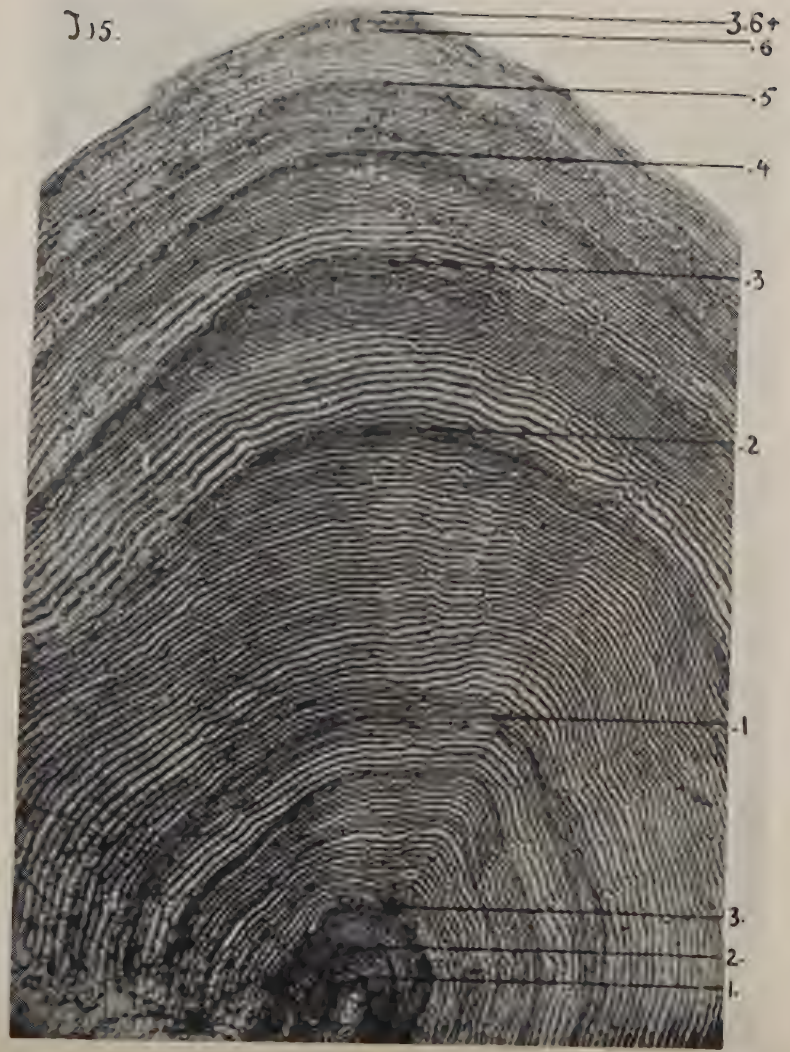


Fig. 27. (J 15) 3.6+ ♂ maiden fish. 15e cm., 28.0 kg., e 18/ 13-7/1926. Oulujärvi, Finland (interzonal, may be C in last year but one).

Fig. 28. (J 16) 2.1 ♂ maiden, with check in 3rd year at sea. + marked on Dec. 12th 1934 in Narvaniemi, Estonia, as 1+ 3/4? ♂. — Recaptured 4/5/1935 at end of Finnish Bay, Unsikirkko, 41 cm., 0.7 kg., in [illegible] length as smolt 19.3 cm.

Fig. 29. (M18) 2.2+, E_0 small summer fish, 76 cm., 4.5 kg.; 15/6/1921, Talmine, Scotland; marked and liberated.

Fig. 30. (M19) 2.2+, E_6 = Fig. 29, recaptured 23/2/1922, Halladale, Scotland; kelt, 76 cm., 3 kg.

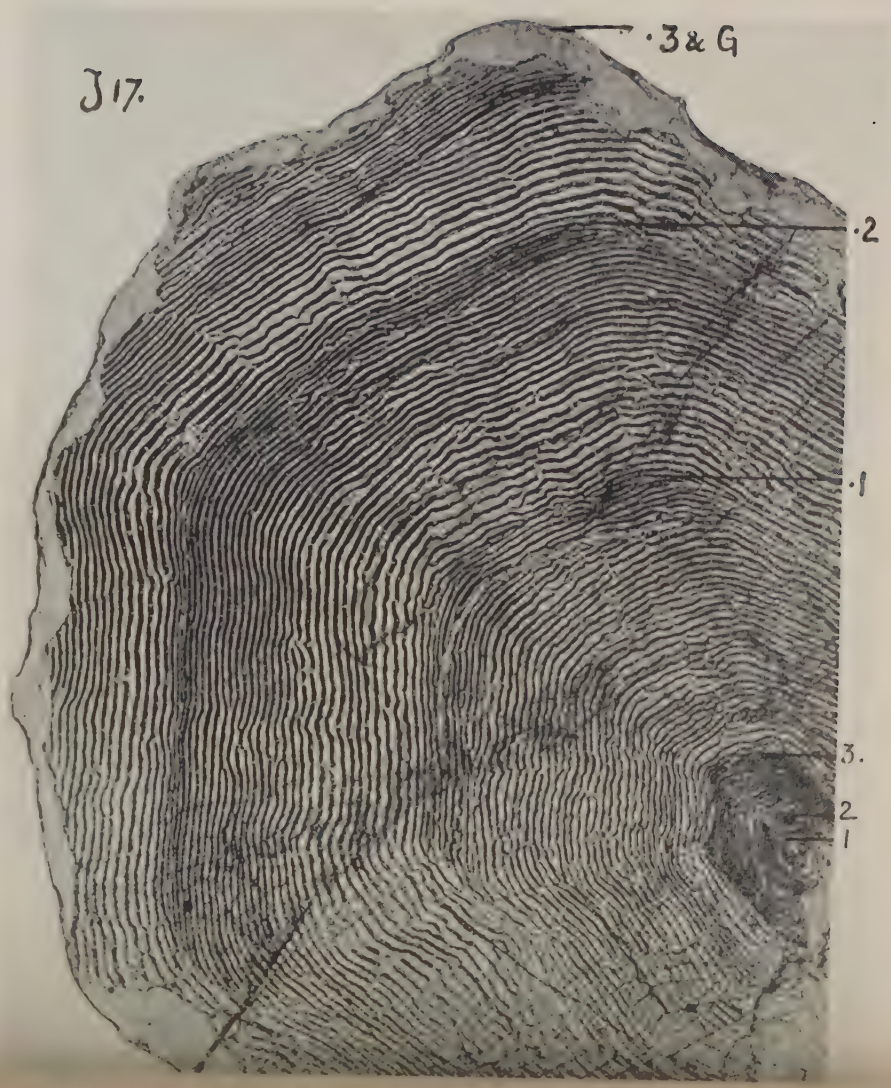


Fig. 31. (J 17) [illegible]

Fig. 32 (M 21) ♀, E_6 ♂ ripe but unspawned, 17.4 kg.; October 1910. Awe, Scotland.

Fig. 33. (M 23) ?.2+, E_1 ♂ kelt (by internal examination) with very little erosion, about 7 kg.; Febr. 1928, Tweed, Scotland.

Fig. 34. (M 24) 3.2+ G 89 cm., 5.4 kg.; April 1923, North Sea 30 miles N.E. Buchan Ness, Scotland. Spawning mark is just forming.

Fig. 35. (J 19) 2.1 — G 2 ♂. 102 cm.. 11.0 kg.. × 22: 26/6 1930.
Kemiriver, Finland. (Sex determined by collector.)

Fig. 36. (J 20) 3.1 — G 3 ♂. 118 cm.. 20.5 kg.. × 21: 28/6 1925.
Kemiriver, Finland.

J 18.
2.3+ = 2.4G 1+
+
.3
G1
.1
2.
1.
Spawning Mark
M 22.

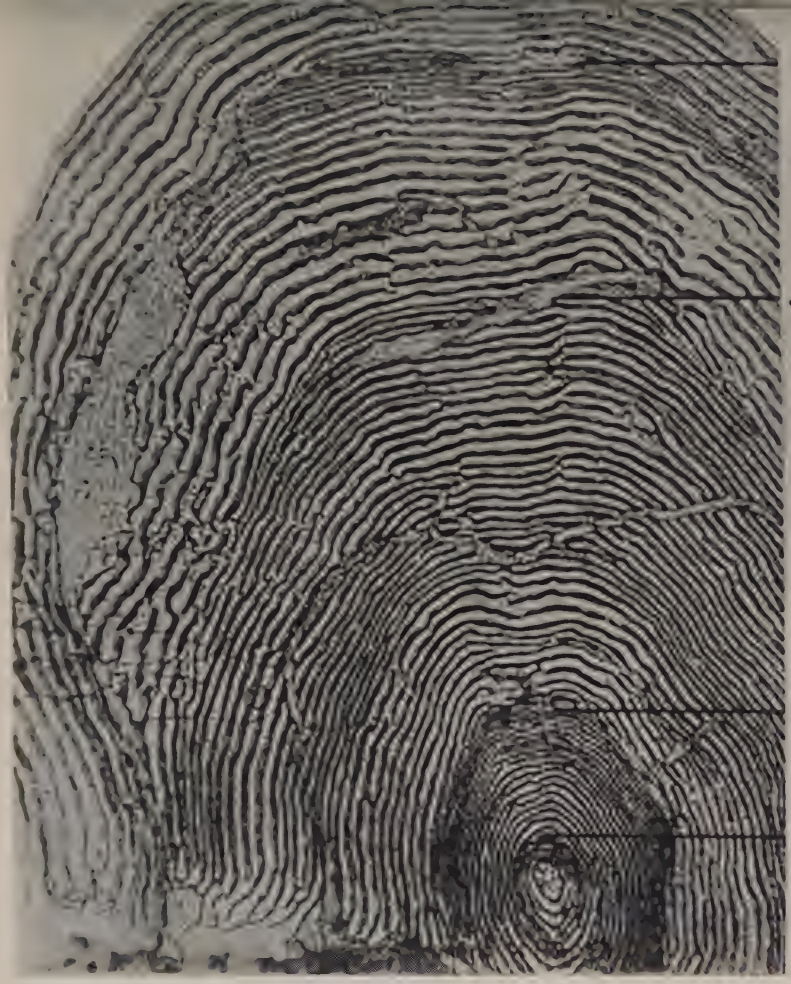


Fig. 39. (J 21) 4.1 + G— ♂, 60 cm., 1.8 kg., × 36; 11.8.1933, Oulujoki, Finland.

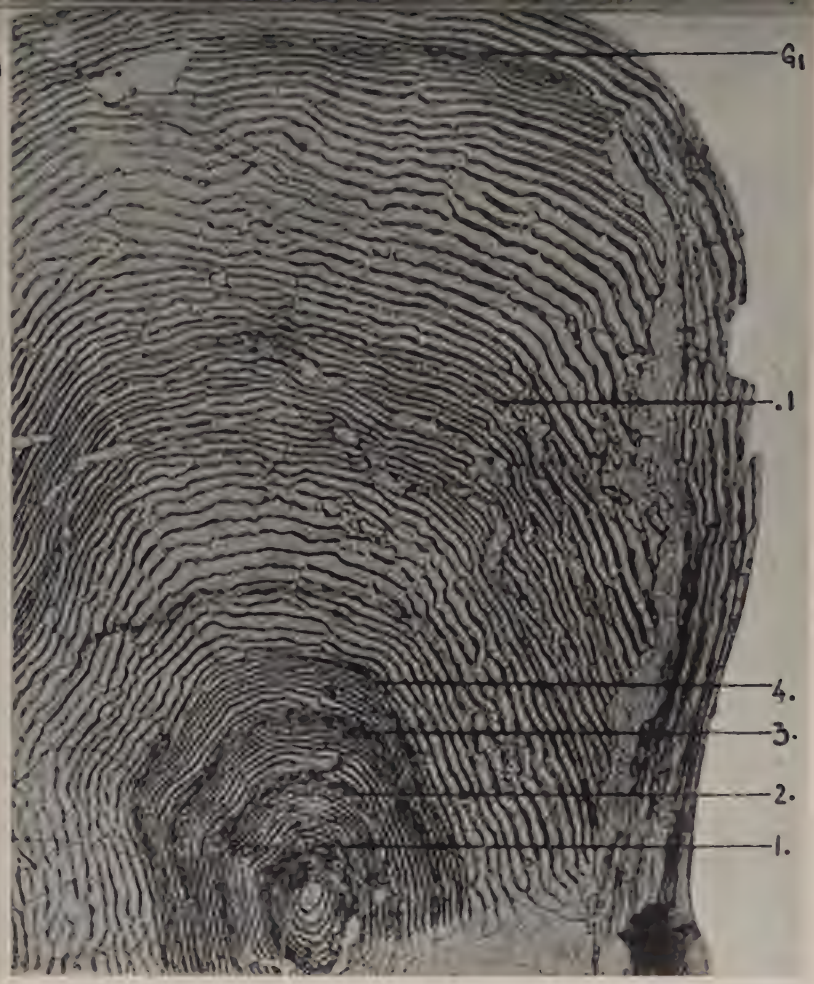


Fig. 40. (J 22) 4.1 + G— 67 cm., 3.0 kg., × 30; 18.8.1931, Tornionjoki, Finland.

Fig. 41. (J 23) 3.3 C 1 C 1 ♀, 118 cm., 18.0 kg., × 21; 18/6/1925, Kemiriver, Finland.

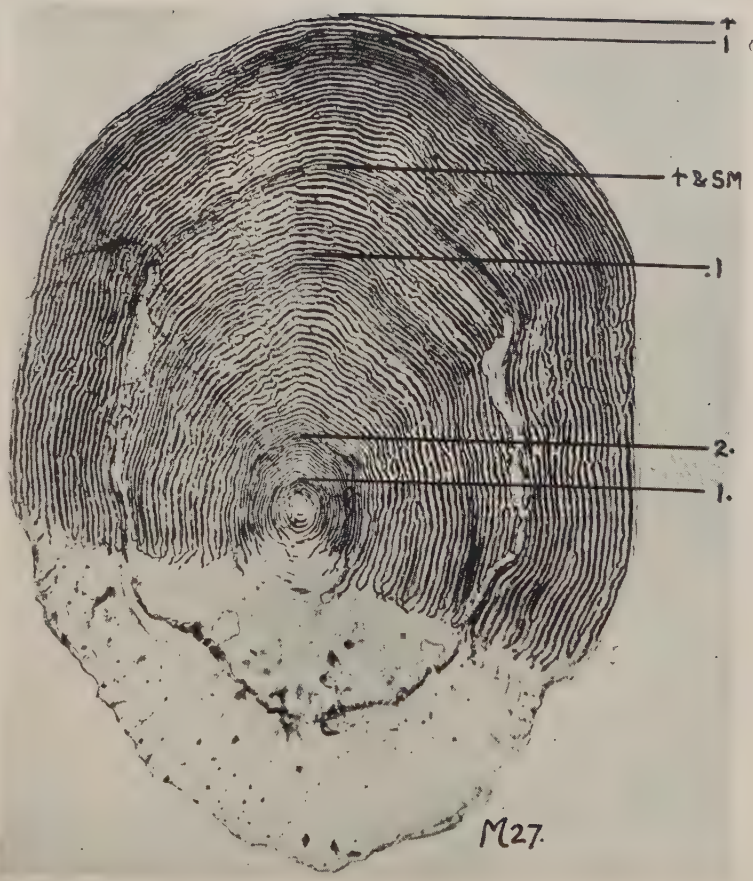
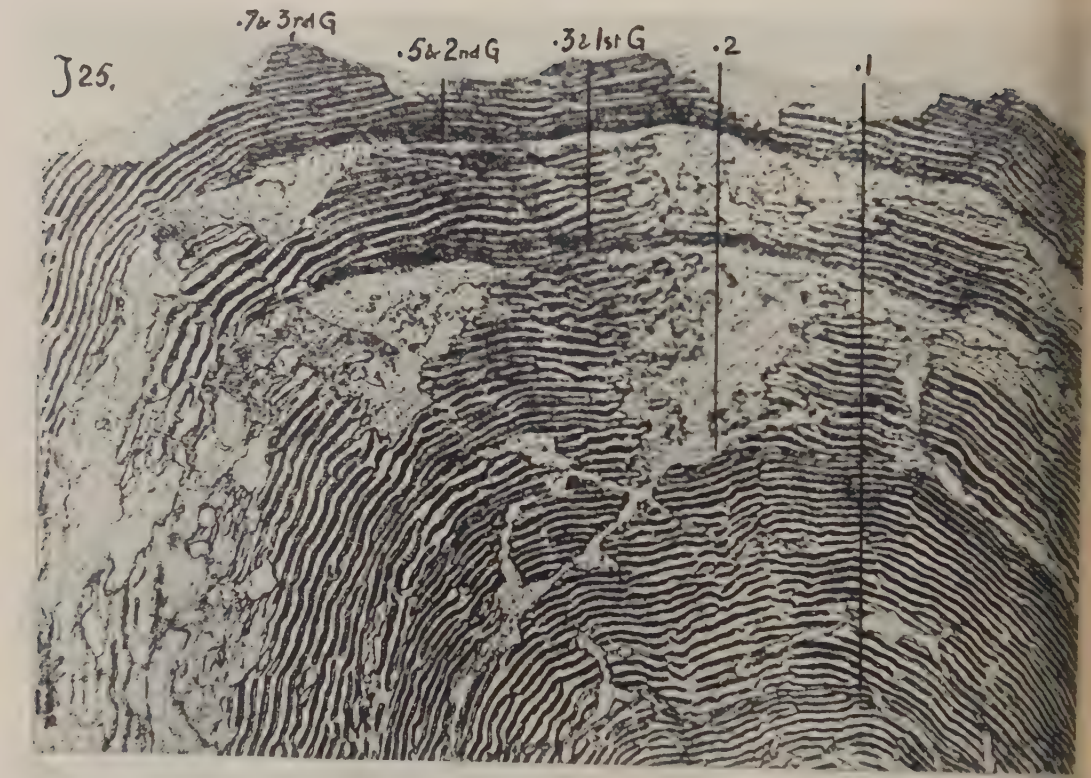


Fig. 42. (M 27) 2.1 + C 1+ 77 cm., 4.5 kg.; 26/5/1924, Spey, Scotland.

Fig. 43. (J 24) 3.3 G 1 G 1 ♀, 110 cm., 16.0 kg., × 21; 5/7/1925, Ouluriver, Finland.



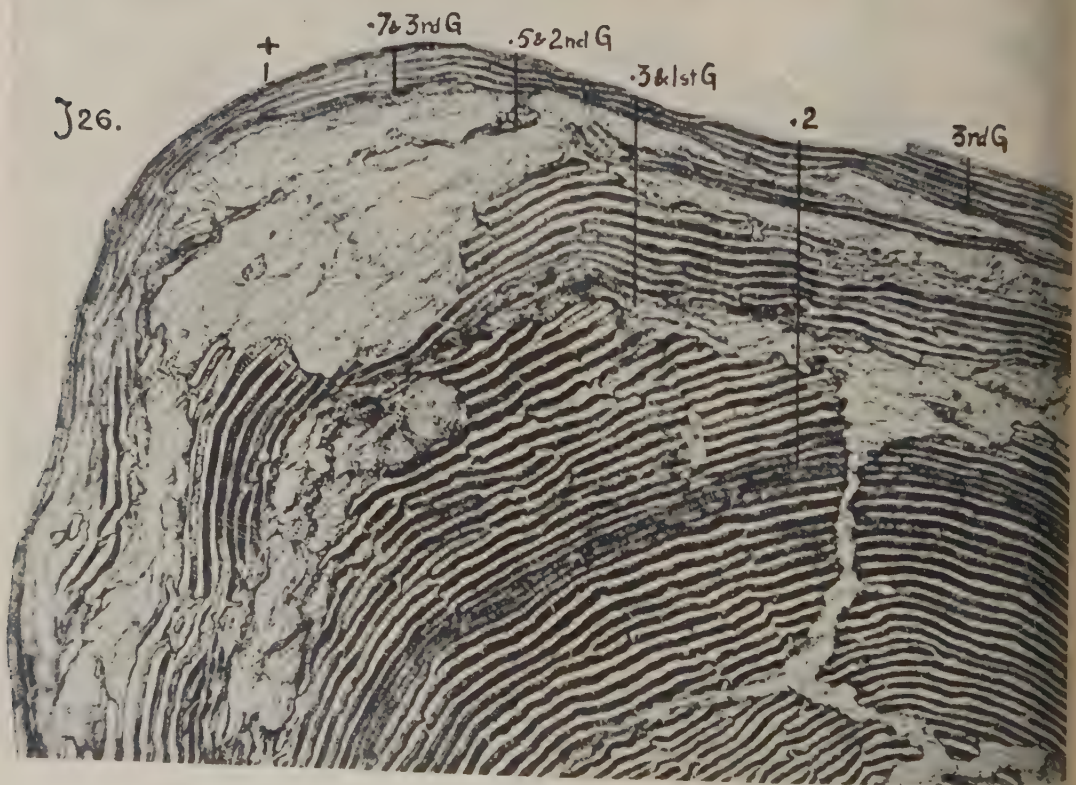
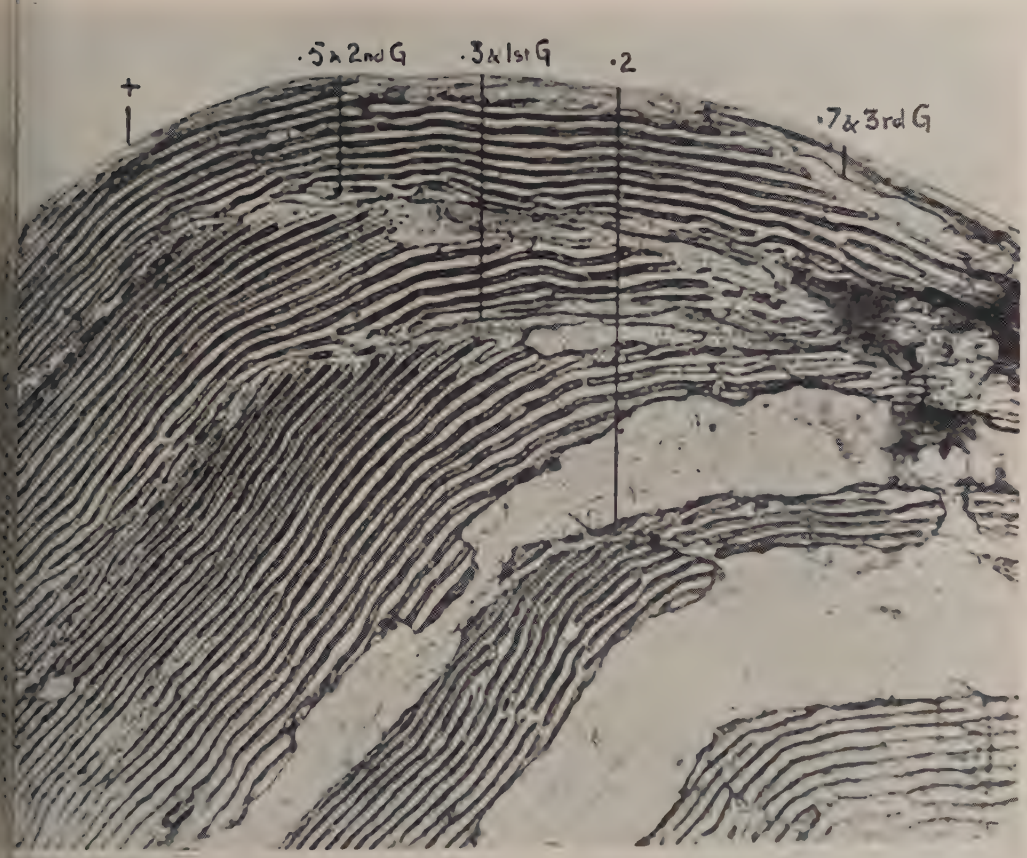


Fig. 44. (J 25) 2.3 G 1 G 1 E_6+ ♀, 108 cm., 13.5 kg., × 27; 26/7/1928, Kymiriver, Finland.
Fig. 45. (J 26) 2.3 G 1 G 1 G 1 ♂, 112 cm., 13.0 kg., × 34; 19/6/1926, Kokemäkiriver, Finland. Erratum: + in figure should be: 1.



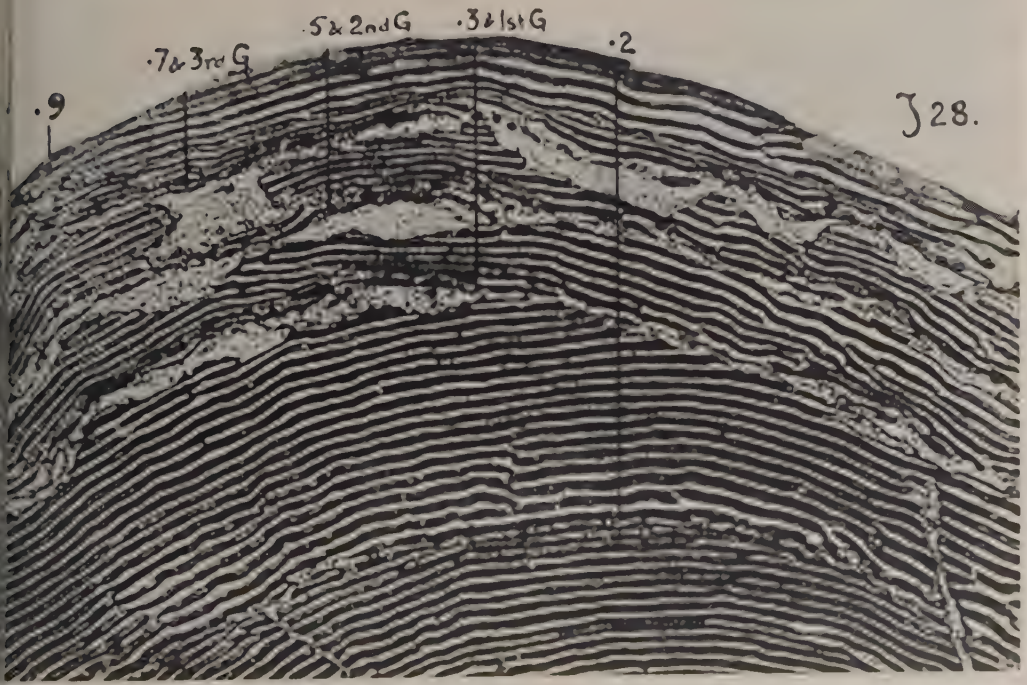


Fig. 46. (J 27) 2.3 G 1 G 1 G + 110 cm., 11.0 kg., × 37; 7/7/1929, Kymiriver, Finland.
Fig. 47. (J 28) 2.3 G 1 G 1 G 1 ♂, 108 cm., 13.0 kg., × 35; 23/6/1932, Kokemäkiriver, Finland. (Sex determined by collector.)

Fig. 48. (J 29) 4.6 with E in 2nd, 3rd, 4th and 5th year 4.1 + G + G + G + G 1 ♂ 124 cm., 19.0 kg., × 16; 9/6.1932. Kemi estuary, Finland. The only specimen out of 20,000 individuals investigated from Finnish waters showing spawning marks in successive years.

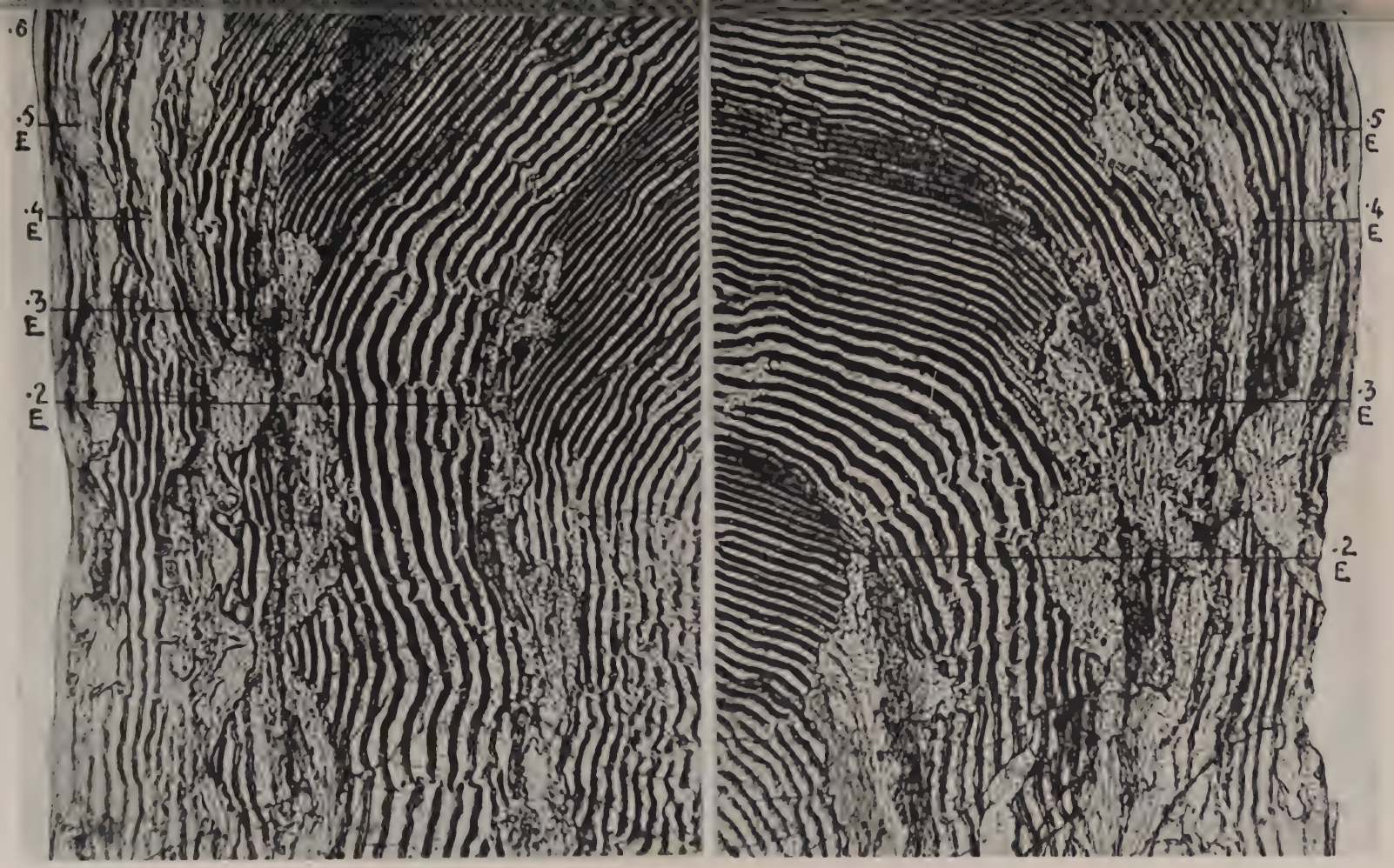


Fig. 49. (J 30) } Left and right corner of Fig. 48; × 32.
Fig. 50. (J 31) }
Marginal notes in Fig. 48 also apply to Figs. 49 and 50.

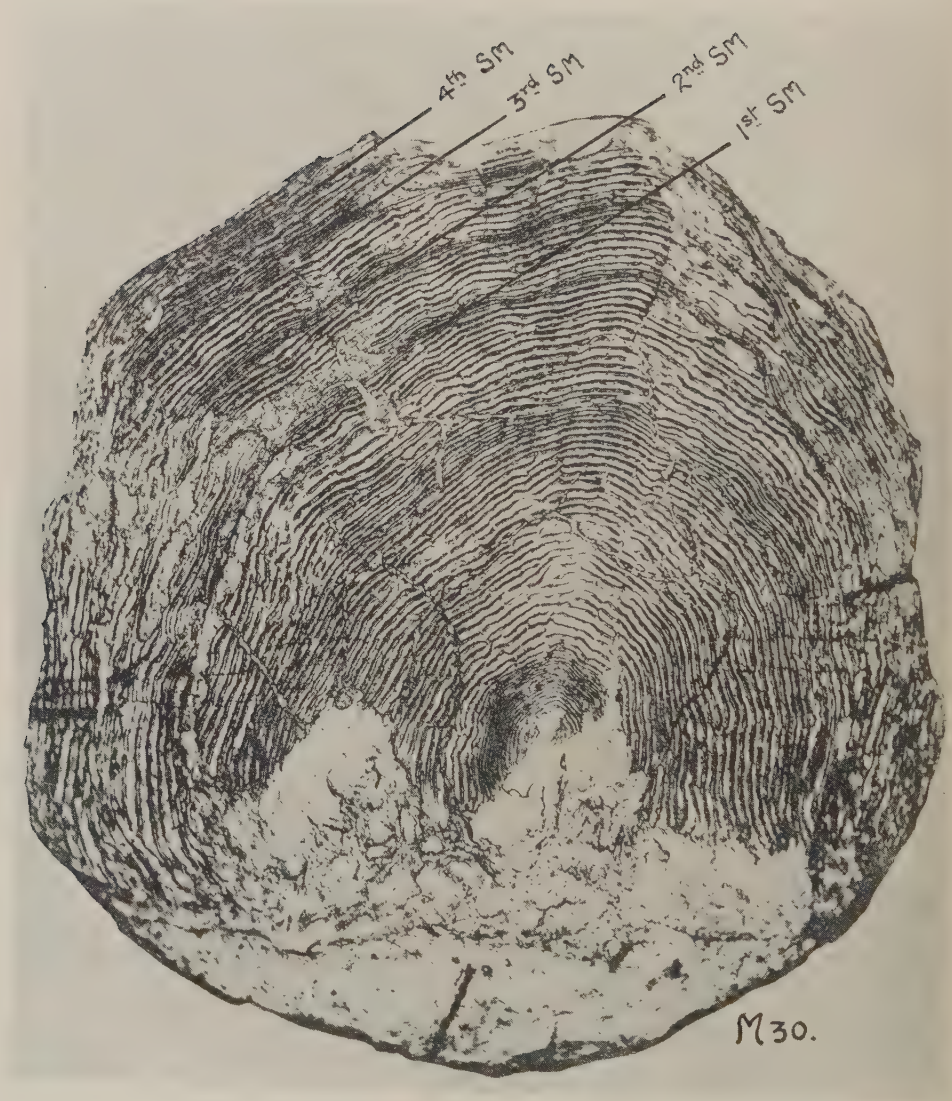


Fig. 51. (M 30) 3.1+ G+ G+ G+ G+ ♀ kelt, 93 cm., 5.6 kg.; 13/2/1915, Add, Scotland.

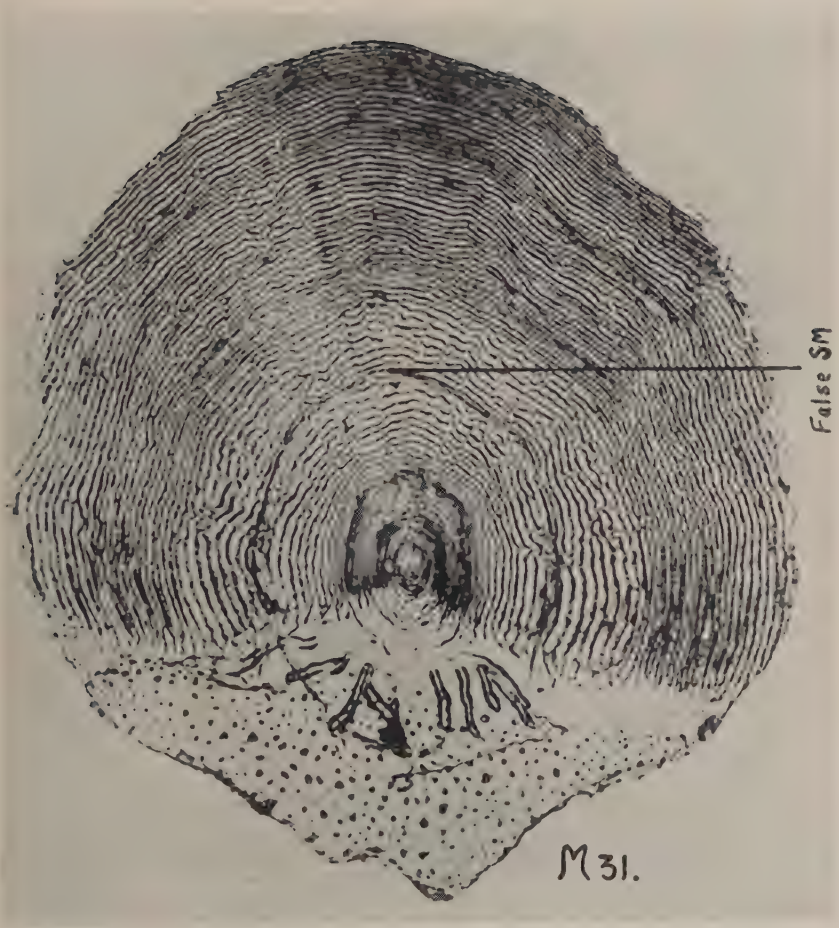


Fig. 52. (M 31) Pseudo spawning mark; Thurso, Scotland.

Fig. 53. (M 35) New centre of growth. ♀, 97 cm., 10 kg.; 10/4/1919, Wye, England. (J. A. Hutton).

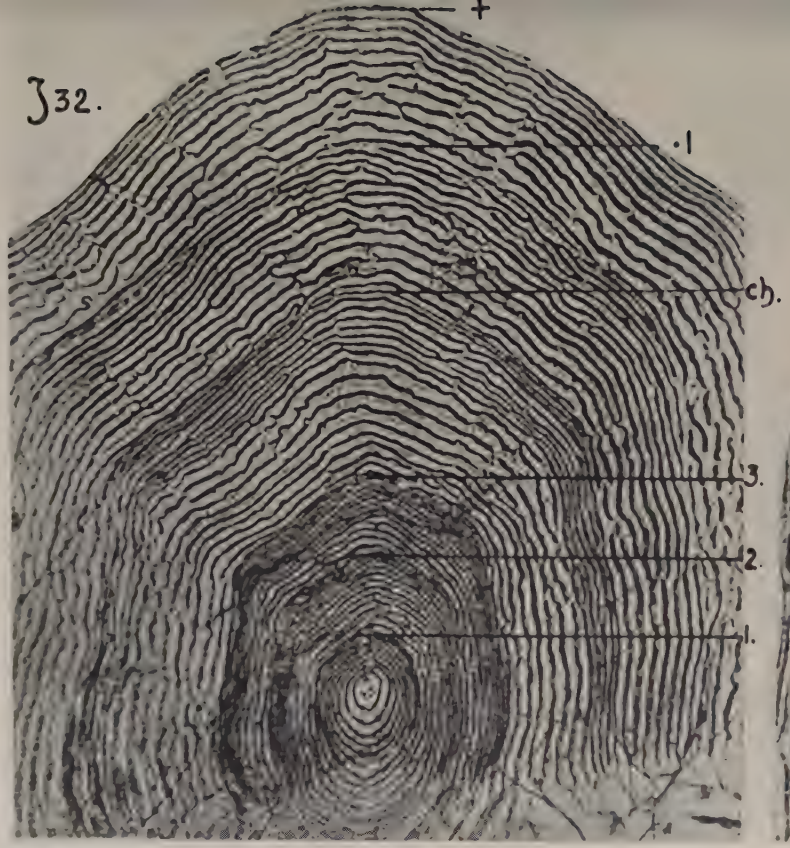


Fig. 54. (J 32) 3.1+ with very distinct check in 1st year at sea; ♀ grilse, 43 cm., 0.7 kg., × 29; 12/7/1932, Tornioriver, Finland. Interpretation doubtful; ch. may be a full year and the scale should then read: 3.2 +

Fig. 55. (J 33) 4.1+ with exceptional small growth in 1st year at sea; ♂ grilse, 39 cm., 0.6 kg., × 34; 21/7/1933, Tornioriver, Finland. Interpretation doubtful .1 may be a river year spent in the estuary and the scale would then read: 5.+ mielnica.

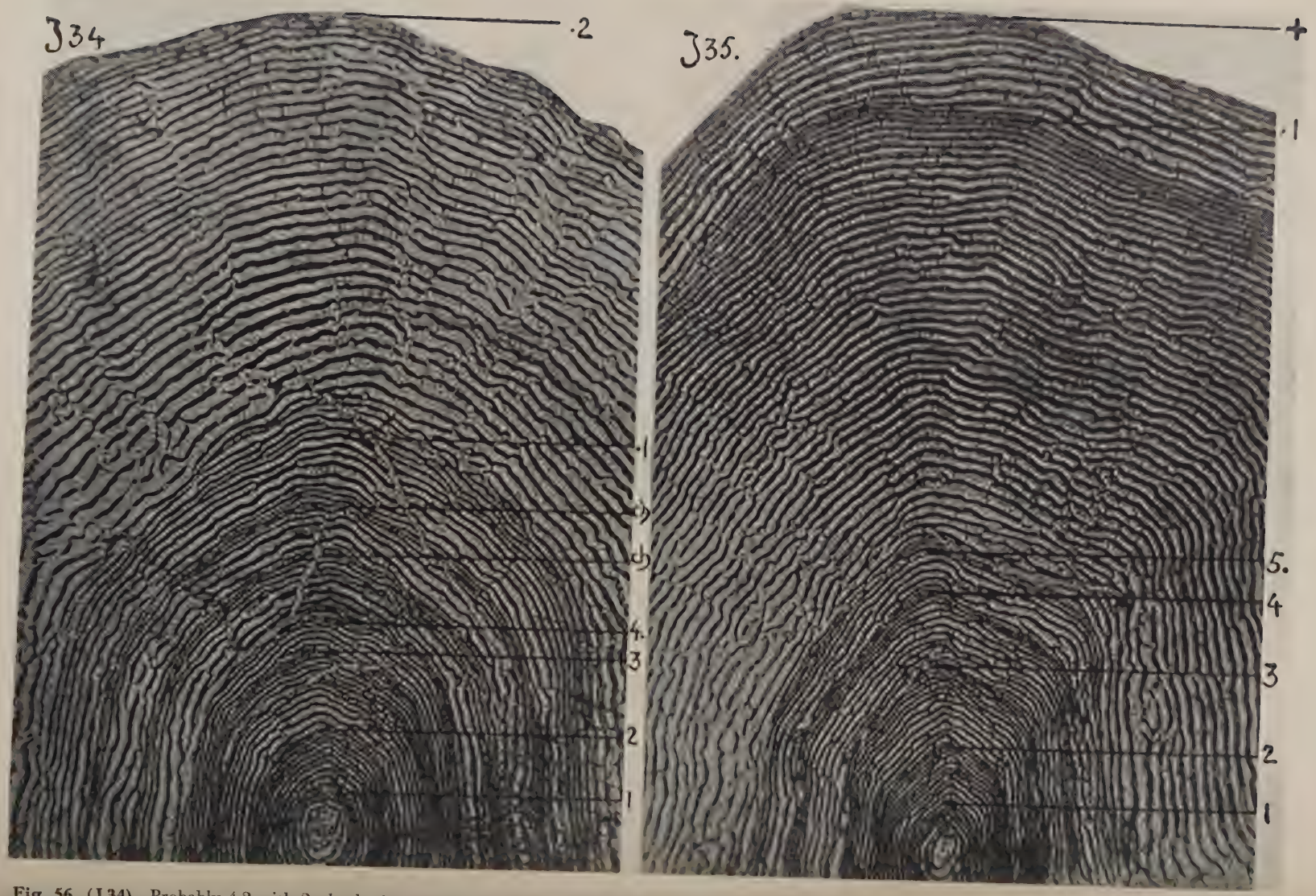


Fig. 56. (J 34) Probably 4.2 with 2 checks in 1st year at sea; ♀ maiden fish. 68 cm. 3.5 kg. ♡ 34. 12/7/1924. Simo, Finland. (see also Fig. 5b).

Fig. 57. (J 35) 5.1+ ♀ grilse with exceptional large growth in 1st year at sea. 70 cm. 4.0 kg. ♡ 34. 12/7/1924.

Fig. 58. (J 36) 3.1+ ♂ grilse with 3 checks in 1st year at sea, 68 cm., 1.3 kg., × 32; 31/7/1933, Ouluriver, Finland.

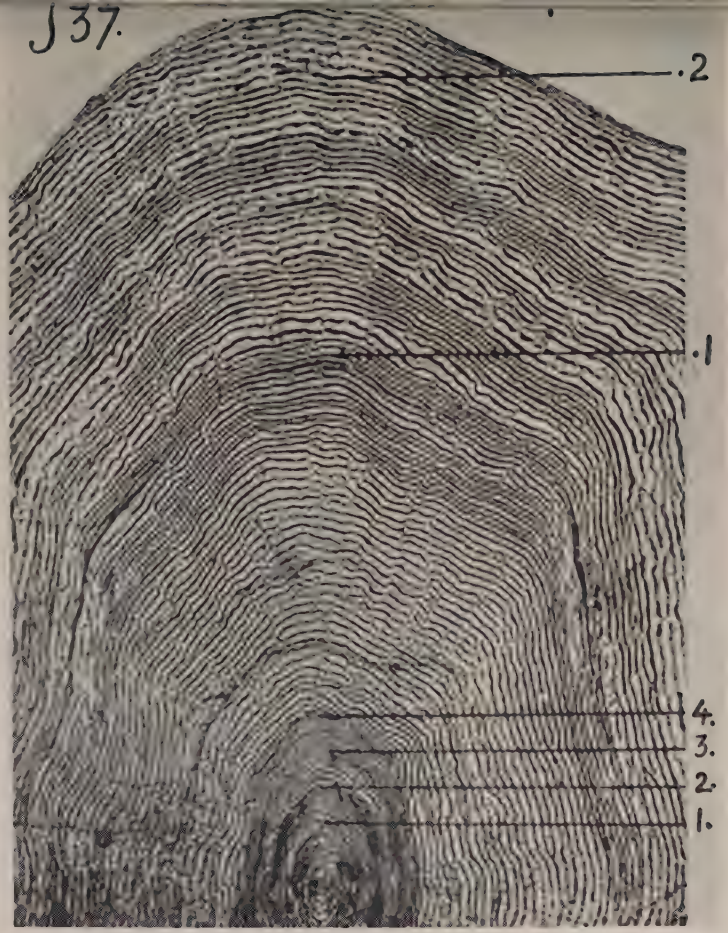


Fig. 59. (J 37) 4.2+ ♀ maiden fish with 3 checks in 2nd year at sea, 90 cm., 8.5 kg × 20; 22/7/1932, Tornioriver, Finland

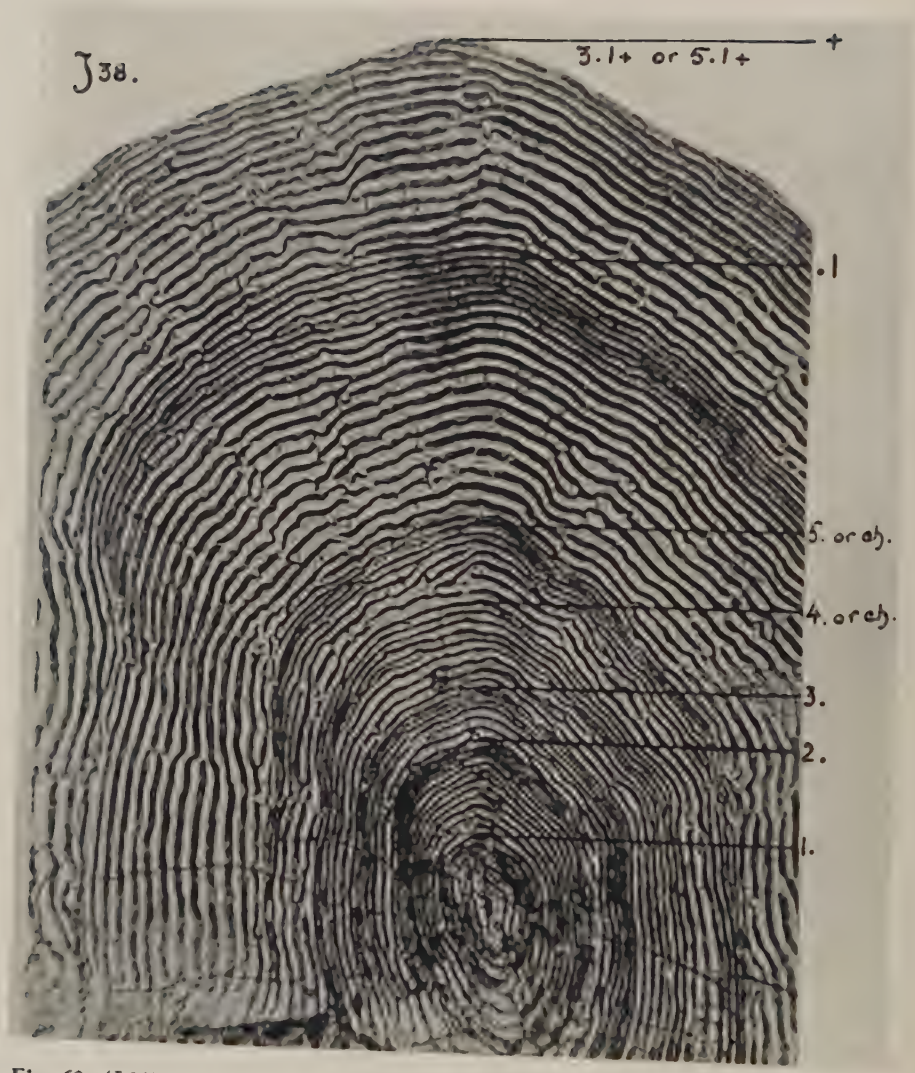


Fig: 60. (J 38) 5.1+ or 3.1+ with 2 checks in 1st year at sea, ♂ grilse, 51 cm., 1.3 kg., × 36; 9/8/1933, Ouluriver, Finland. Very difficult to determine. "3." may be "check", also "1." may be 2. with regenerated centre, in which case the interpretation will be 3.1+ with 3 checks in 1st year at sea.

Fig. 61. (J 39) 3.1+ G 1+ with distinct check in 1st year at sea. ♂ 65 cm., 3.3 kg., × 30; 3/7/1933, Tornioriver, Finland.

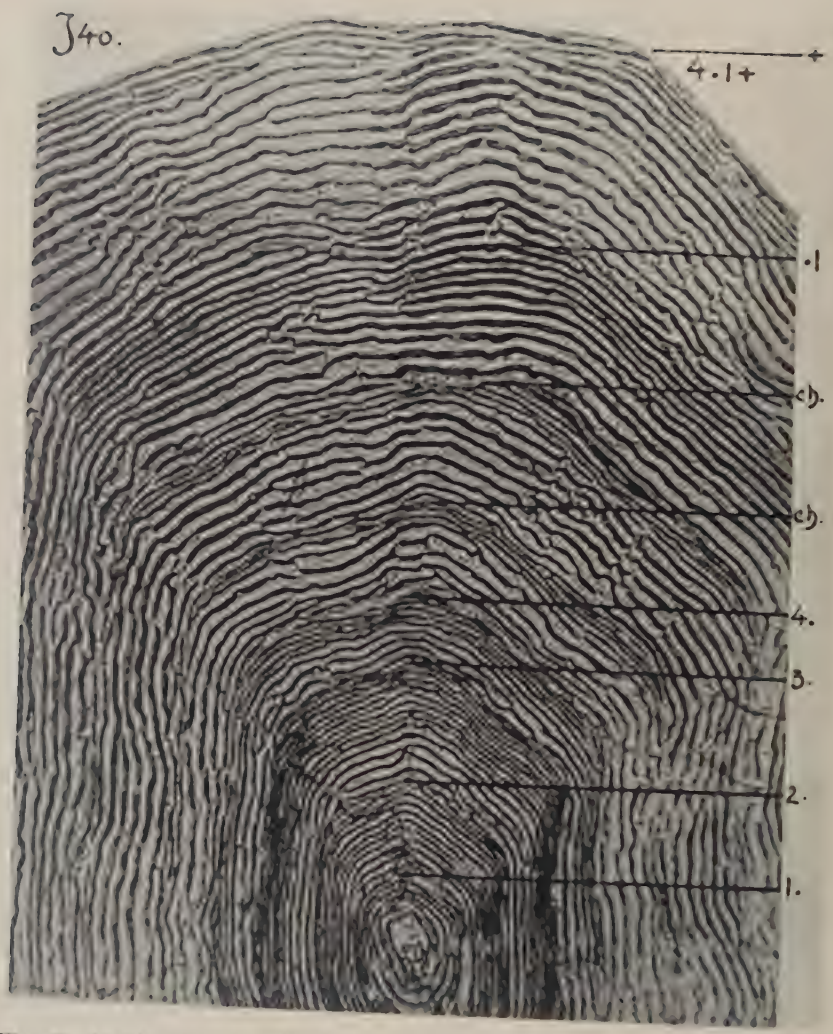


Fig. 62. (J 40) Exceptionally difficult to read, probably 1.1+ ♂ grilse with 2 sharp checks in 1st year at sea, 47 cm., 0.95 kg., × 36; 9/8/1933, Tornioriver, Finland.

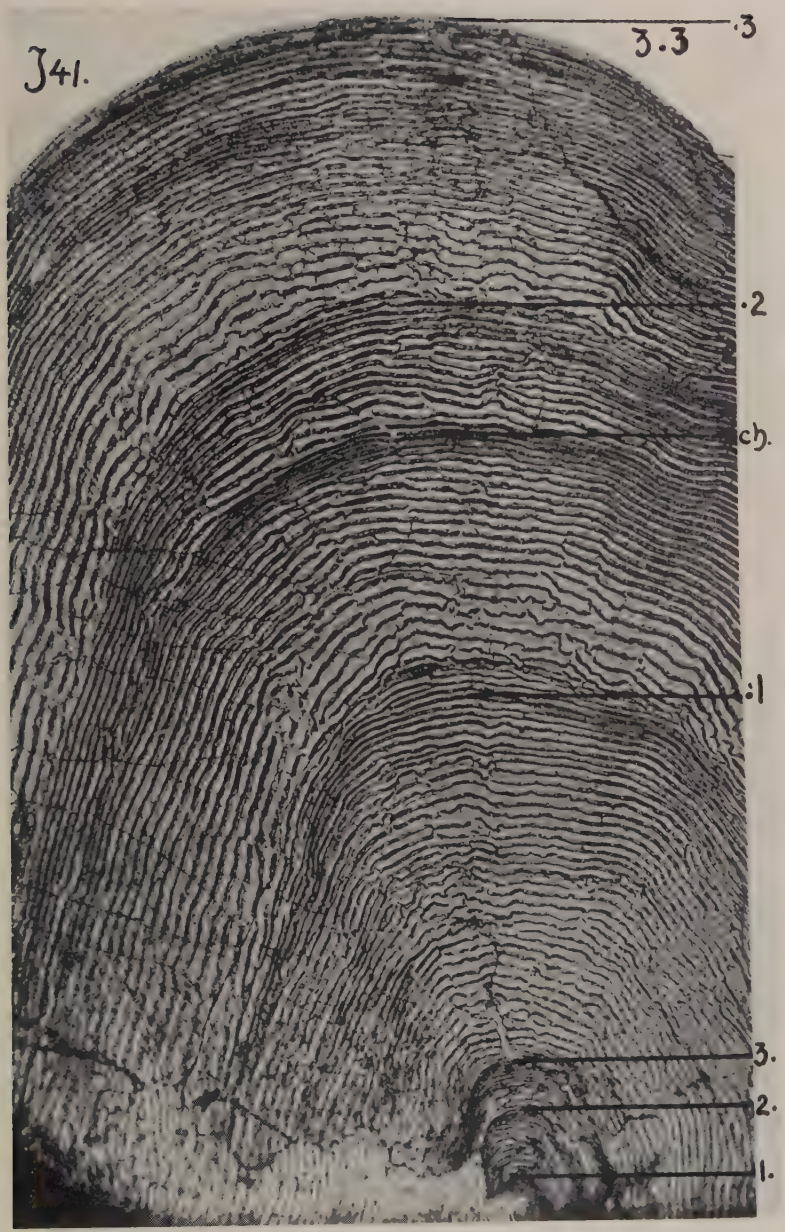


Fig. 63. (J 41) 3.3+ ♂ fish with sharp check in 2nd year at sea, 115 cm., 16.0 kg., × 22; 24/6/1933, Kemiriver, Finland. Possibly "ch" should be read "2" and "2" the result of misplacement and slight turning of scale in skin pocket.

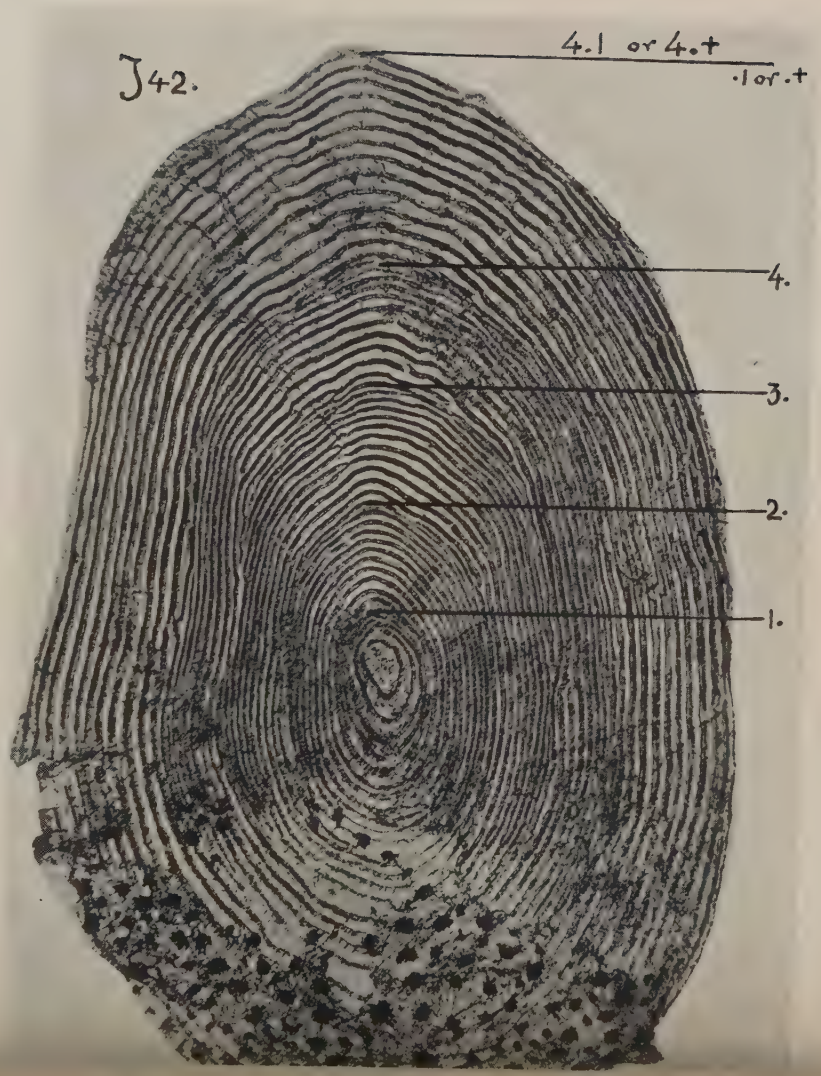


Fig. 64. (J 42) +.: maiden fish, sex unknown, 32 cm.,

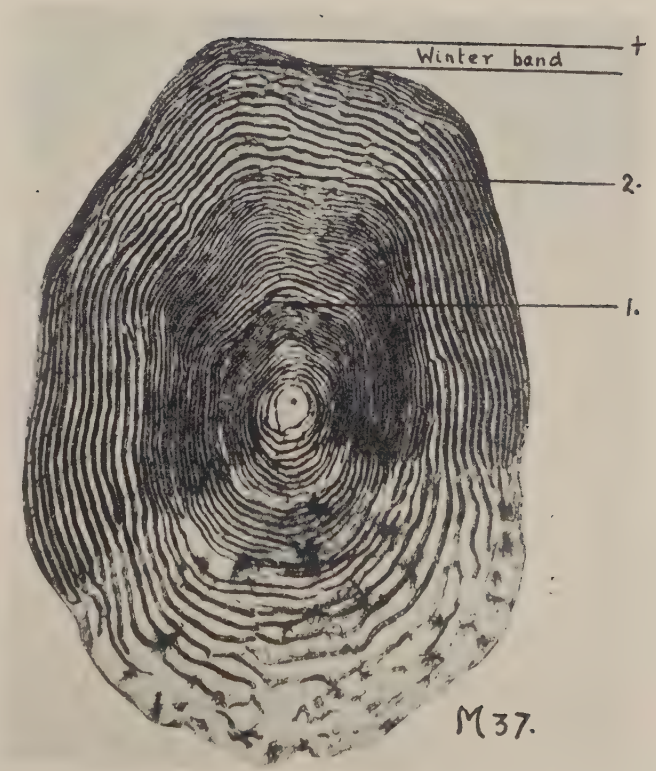


Fig. 65. (M 37) 2.+ finnock with winter band, 31.5 cm., 0.35 kg.: 21/2/1927. Roag, Scotland.

Fig. 66a. (M 38) 2.- finnock, marked 9/11/1931. Graemeshall; 30.5 cm.. 0.37 kg.

Fig. 66b. (M 39) 2.1+ when recaptured 28/9/1932, Graemeshall Beach; 39 cm., 0.68 kg. (Same fish as 66 a)

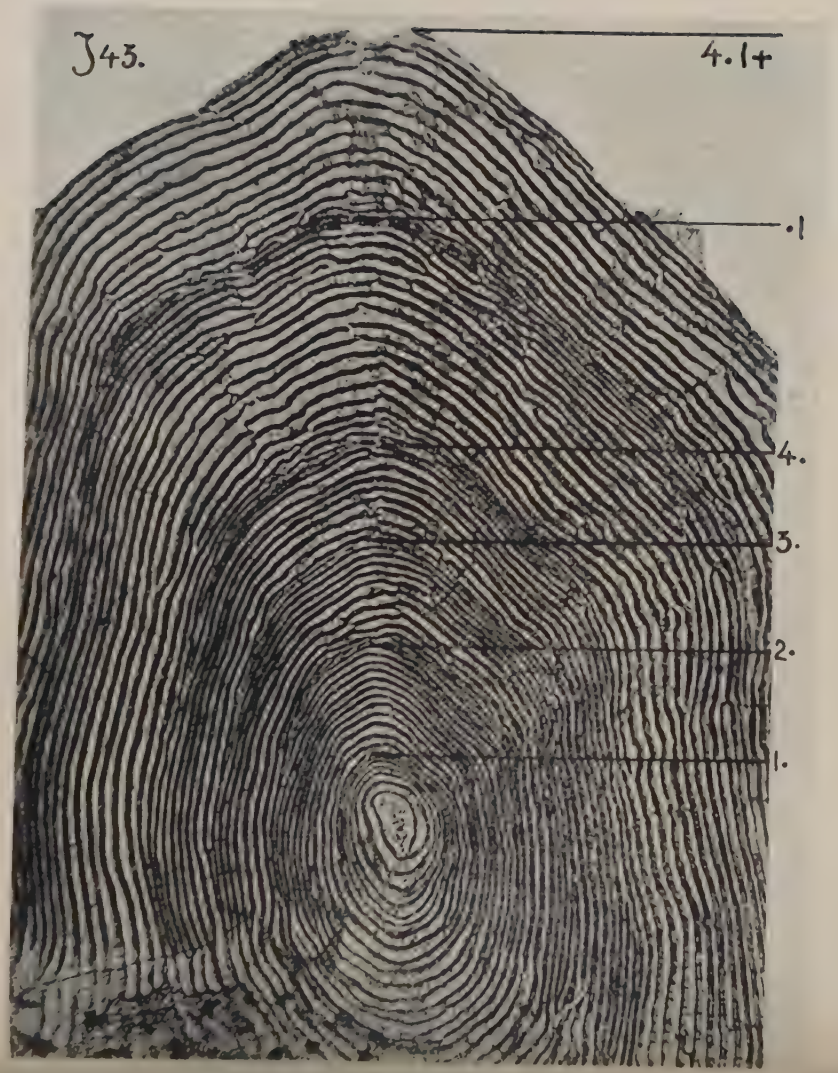


Fig. 67. (J 43) 4.1+ maiden fish, 40 cm., 0.75 kg., × 37; 28/8/1929 Kemijärvi estuary, Finland.

Fig. 68. (M 40) 3.2+ maiden fish, 39.5 cm., 0.65 kg.; 18/8/1921, Loch Hope, Scotland.

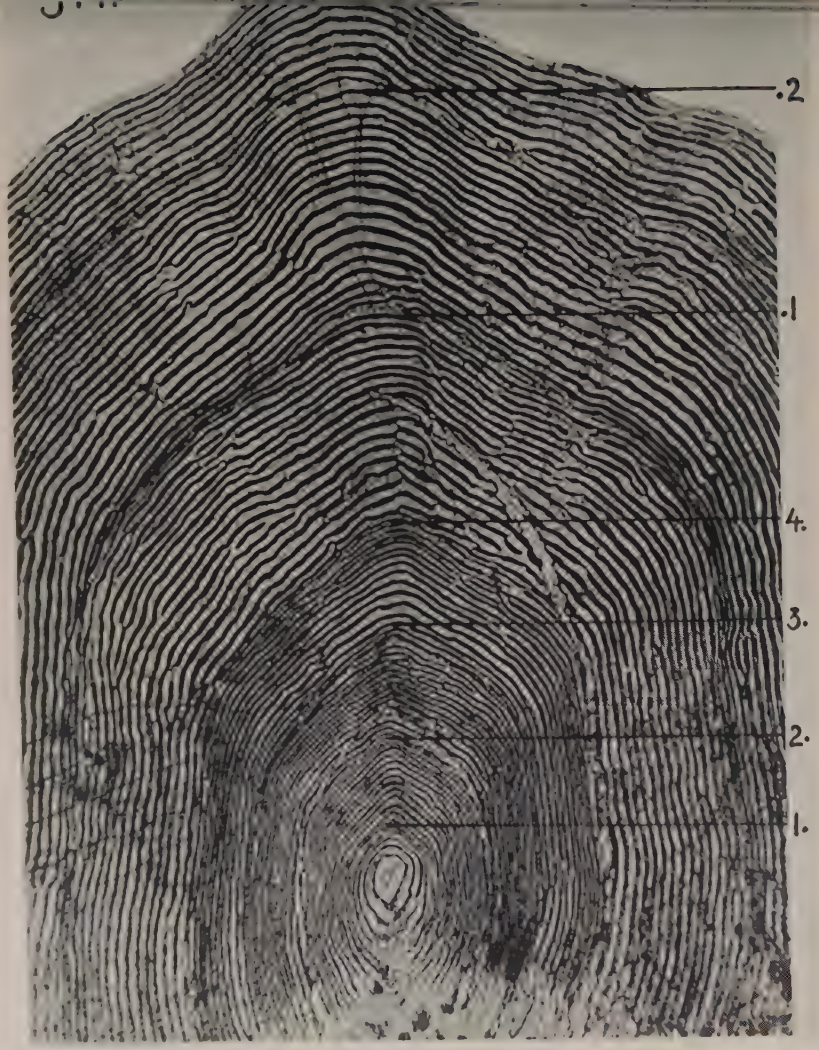


Fig. 69. (J 44) 4.2– ♀ maiden fish, 60 cm., 2.7 kg. × 34; 28/8/1929, Kemiriver estuary, Finland.

Fig. 70. (J 46) 3.3– maiden ♂ fish, 65 cm., 3.7 kg., × 34; 28/8/1929, Kemiriver estuary, Finland.

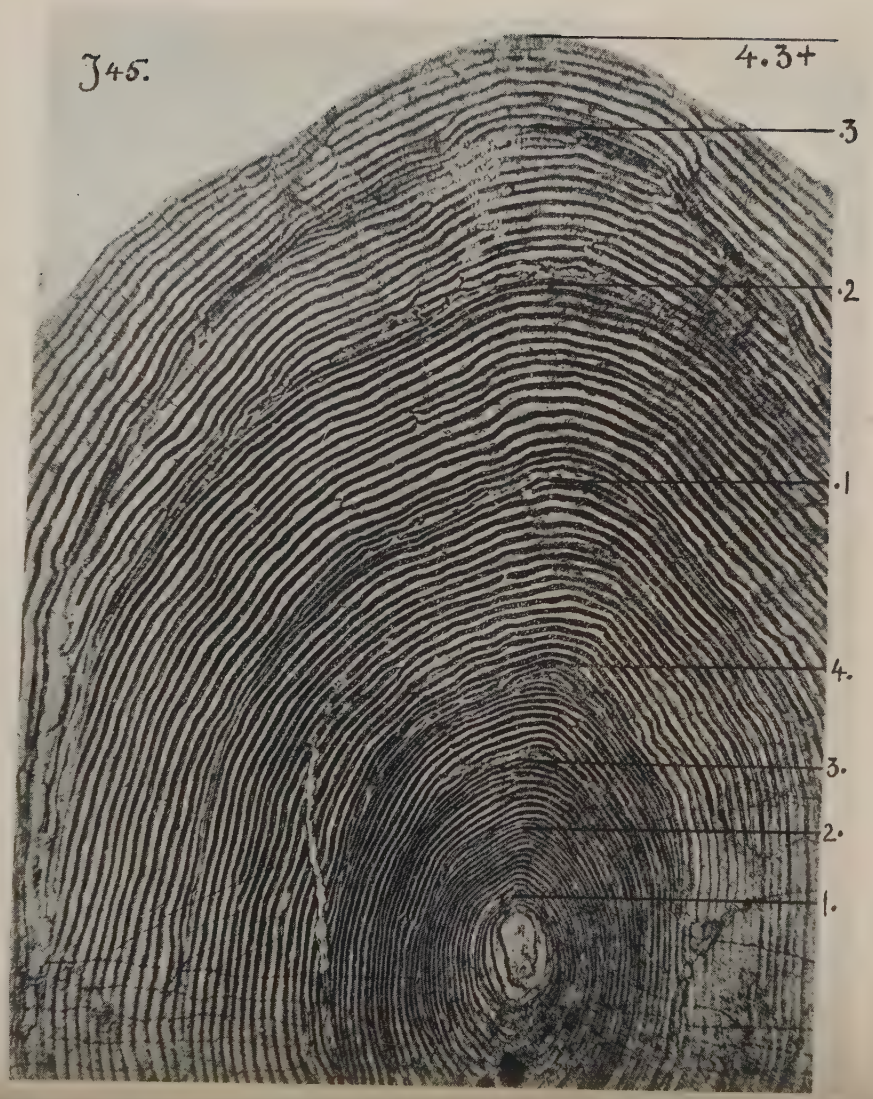


Fig. 71. (J 45) 4.3 G+ ♀, 61 cm., 4.5 kg., × 34; 28/8/1929, Kemiriver estuary, Finland.

Fig. 72. (M 47) 3.1+ maiden ♂ fish, 46 cm., 1.1 kg.; 12/5/1925, Ailort, Scotland.

Fig. 73. (J 47) 3.4 G+ ♂, 77 cm., 5.5 kg., × 34; 28/8/1929. Kemiriver estuary, Finland.

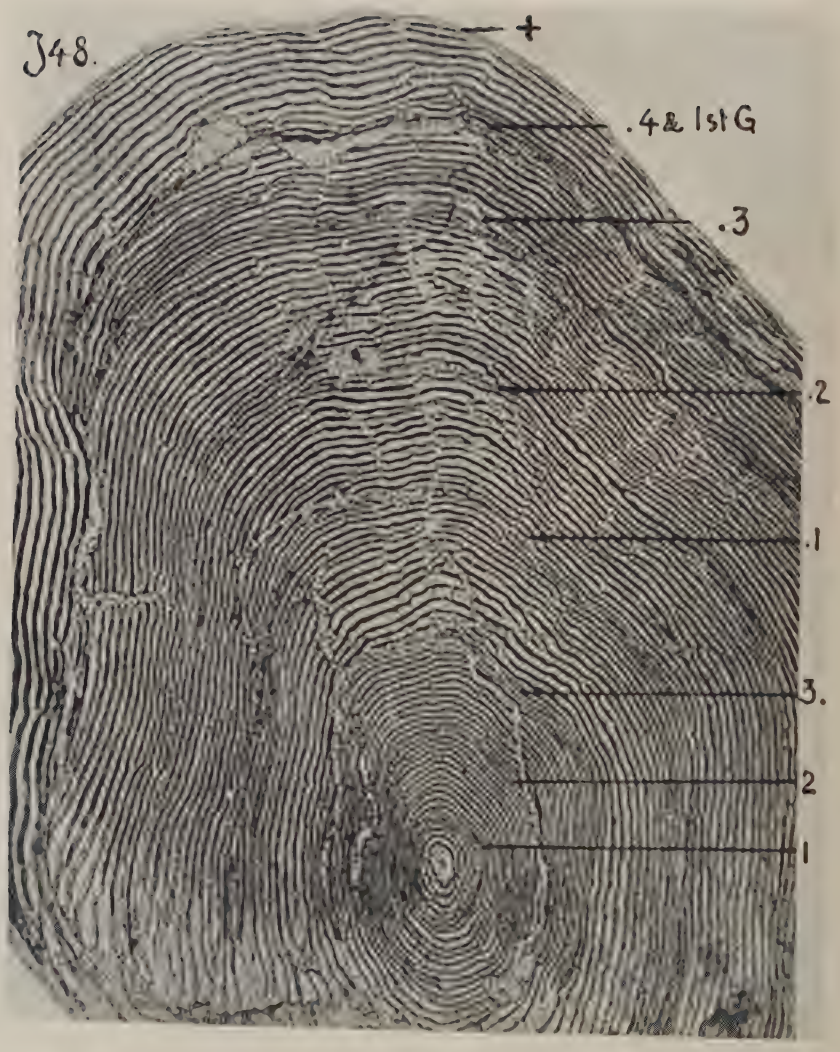


Fig. 74. (J 48) 3.3 G+ ♀, 78 cm., 8.0 kg., × 28; 20/10/1933, Kemiriver, Finland.

Fig. 75. (J 49) 3.4 G 1 G 1 G 1 ♂, 94 cm., 9.5 kg., × 26; 15/7/1927, Ouluriver, Finland.

Fig. 76. (M 43) 3.2+ 3 G+, E_1 6.6 kg.; July 1930, Loch Ba., Scotland.

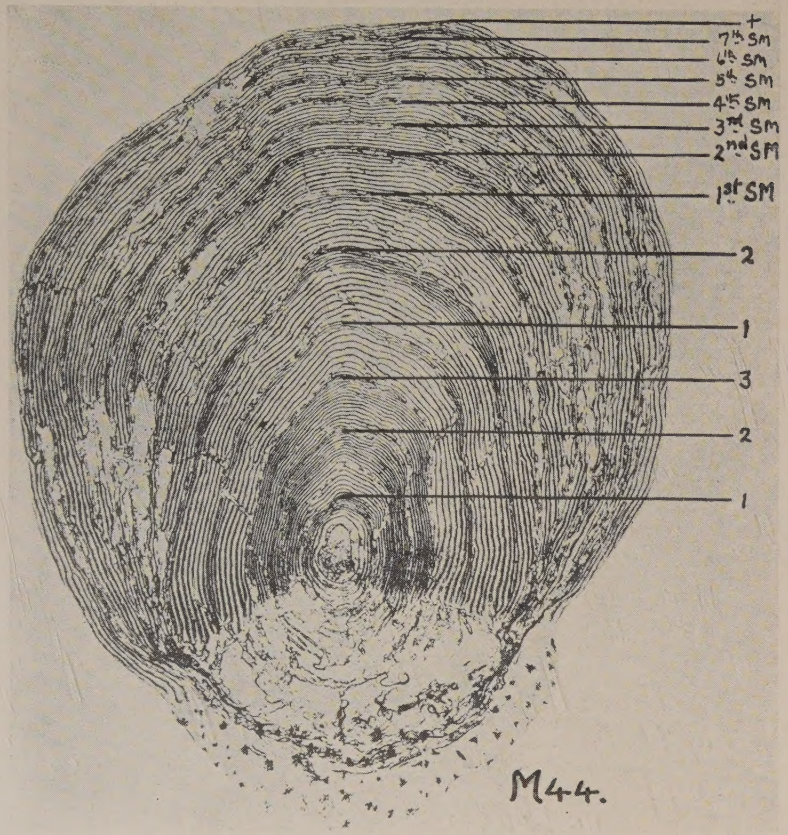


Fig. 77. (M 44) 3.2+ 7 G+ 78 cm., 5.4 kg.; 8/6/1925, Ailort, Scotland.

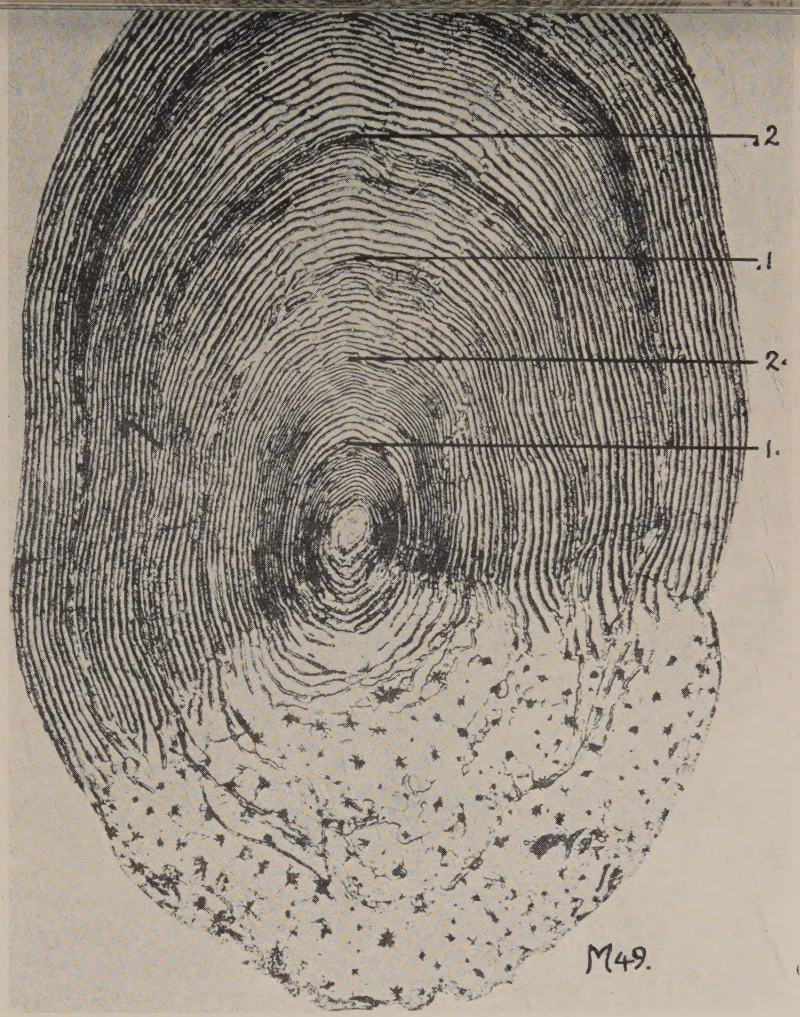


Fig. 78. (M 49) 2.2+ G+ with slight spawning mark, 70 cm., 3.35 kg.; 4/9/1925, Loch Eilt, Scotland.

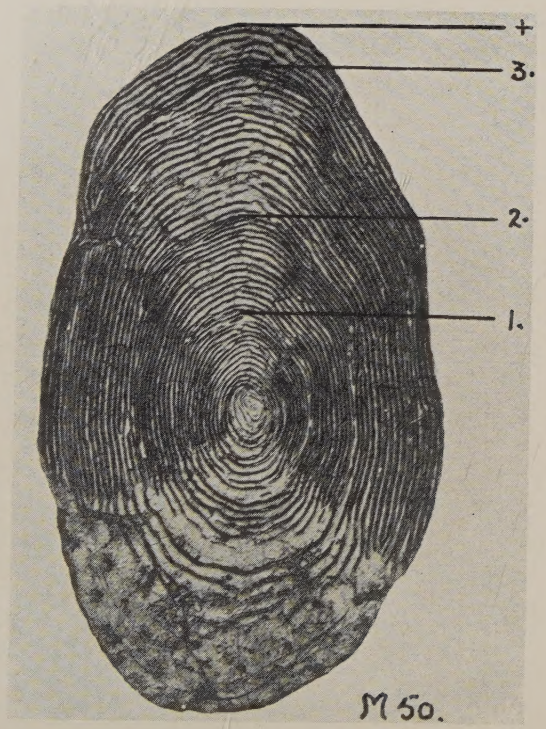


Fig. 79. (M 50) 3+ brown trout, 27.5 cm., 0.22 kg.; 18/11/1925, Ythan, Scotland.

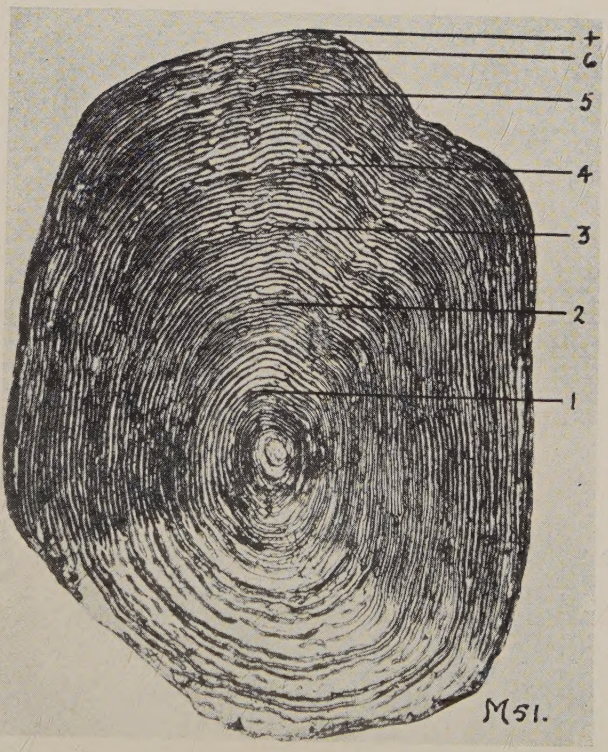


Fig. 80. (M 51) 6+ brown trout, 33 cm., 0.36 kg.; 2/9/1924, Ewe, Scotland.

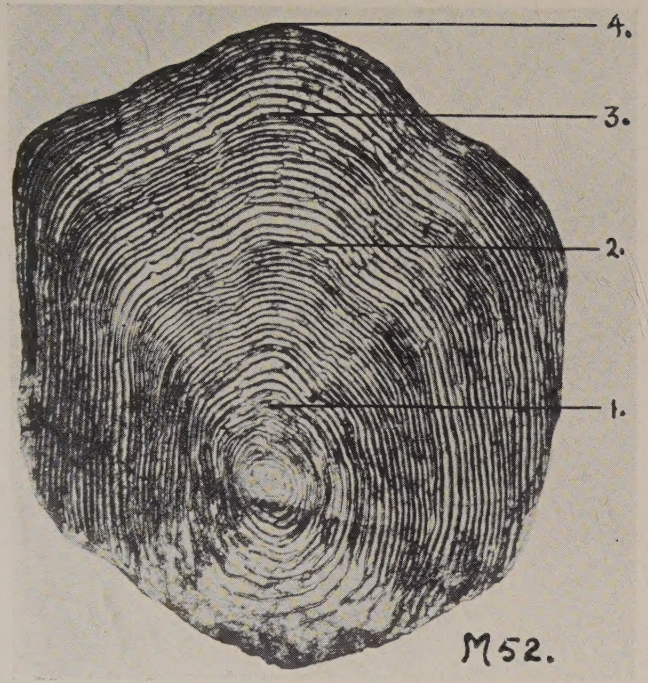


Fig. 81. (M 52) 4 brown trout with erosion; 38 cm., 0.5 kg.; 25/11/1927, Loch Leven, Scotland.

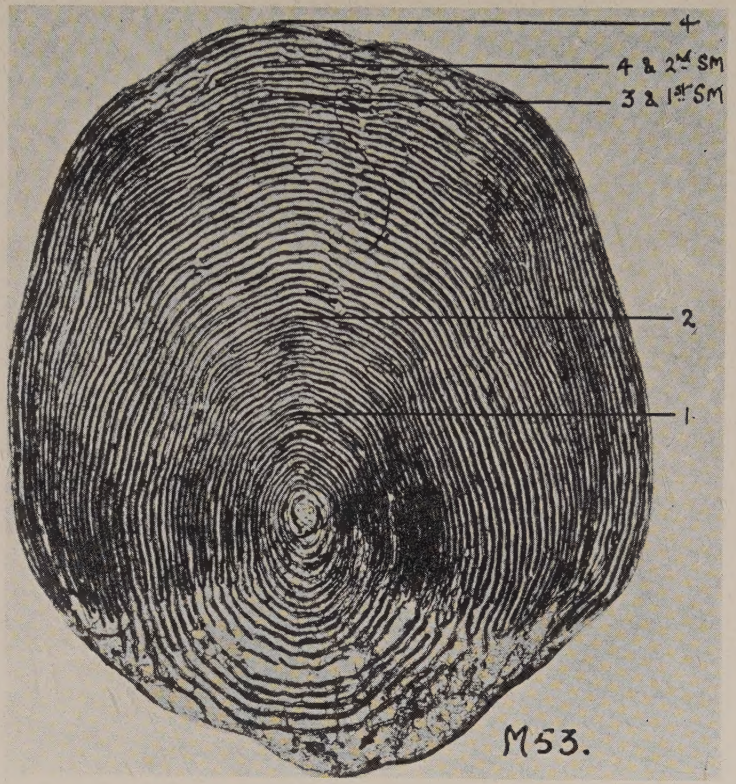


Fig. 82. (M 53) 2+2 G+ brown trout, spawning mark in 3rd and 4th year; 34.5 cm., 0.475 kg.; 1/6/1930, Test, England.